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ANNALS *of* SURGERY

VOL. LXXII SEPTEMBER, 1920 No. 3

SOME OF THE THINGS THAT SURGEONS AS A PROFESSION STAND FOR*

BY WILLIAM WILLIAMS KEEN, M.D.

OF PHILADELPHIA, PA.

EMERITUS PROFESSOR OF SURGERY IN JEFFERSON MEDICAL COLLEGE

IT is trite, but profoundly true, for me to say that the distinguished honor you conferred upon me six long and fateful years ago, in April, 1914, in New York City, is deeply appreciated. How ignorant we were as to what was then "in the lap of the gods!" How little we dreamed that in three months' time the dogs of war would be loosed on faithful Belgium and heroic France; that when Britain's honor was touched, she, too, would spring to arms in defense of the Rights of Humanity, of the sacredness of what the whole civilized world recognized as solemn binding treaties, but which Germany deemed only "scraps of paper!"

The heart of the people of America was with you then and is with you to-day. Many of us tugged at the leash when the Louvain Library was given to the flames, when Rheims was ruined by the representatives of Kultur, and still more when the *Lusitania* was torpedoed without warning and went to the bottom in twenty-one minutes. Eleven hundred and fifty-four men, women, and children, including one whom we all loved—a gracious woman on an errand of mercy—were thus murdered by the pitiless Huns. I have seen the coarse, misdated medal struck by the Germans to commemorate forever this hideous crime.

Many of us are also tugging at the leash to-day, longing to help you in your hour of peril. We resent the sinister influences at work, even in some high places, to create dissension between us and our "Allies," as I love to call you. We would gladly throw in our lot with you all—Belgium, Britain, France, Italy, Portugal, and Japan.

What amazing courage and steadfastness you have shown. What impossible things you have done on plain and on mountain peak, in trench and in hospital, on land, on the sea, under the sea where you were comrades of the fish, high in the air where you outstripped and were the envy of the eagle.

We were lost in admiration of your prowess, and suffered with you

* The presidential address at the Fifth International Congress of Surgery, July 19, 1920.

in your sacrifice of those that were dearest to you. Even in your hours of defeat instead of yielding to despair you showed what the inspiration of adversity could do, and plucked victory from the Hun.

Finally, when we Americans were allowed to come to your aid, how exultantly our young men and old men, young women and old women sprang to your help and were at least of some aid, though at the eleventh hour. It will always be a joy to us that Château-Thierry was the nearest approach of the Huns to Paris—a perilous nearness of but half a hundred kilometres. There, with uplifted and forbidding hand our message ran: "Thus far and no further," "and it was so," as saith the Scriptures of the Creative Week.

How prophetic, though all unconscious, was the presidential address of that noble Belgian, Professor Depage, in April, 1914! How he turned words into deeds of great pith and moment at La Panne! What lessons in the surgery of wounds he taught us!

How splendidly all of you wrought not only for humanity, but for science! In the four years of the war, how you have transformed surgery! A new era dates from 1914 to 1918!

For me to attempt to discuss any surgical subject before you would be presumptuous. It is for me to sit at your feet and learn how you have acquired your present affluence of surgical knowledge.

In this address, therefore, I venture to recall to your minds some of the things which we as a profession should stand for.

I regret that I can only give a brief paragraph or two to each topic. As to some, you will not all be in accord with me. I can only state my own belief as to what is, or ought to be, the attitude of our guild.

1. *Education.*—I need only to point you to one so lately rapt from us, Osler the scholar, who taught us all what we should study; not only practical medicine in its various branches, among which we may have a chosen one, but the history of medicine, the biographies of our past heroes; nor yet only medicine, but the humanities representing the "Literature of Power" as contrasted with the "Literature of Knowledge"; not only solid prose, but cadenced poetry, with its wings to lift us towards the stars; not only modern literature, but we should also drink of the old, old fountains of inspiration from Judea, Greece, and Rome. Medical education, strictly so called, has made great strides in the last thirty years due to the persistence of the leaders in medical thought and influence. It must still progress *semper et ubique*.

2. *Research.*—I need only pronounce the word to awaken in your minds the contrast of the last years of the great war with the first year when you were groping your way to the light. The absolutely proved conquest of typhoid, typhus, tetanus, smallpox, and perhaps above all the victory over unparalleled infection, are eloquent witnesses to the value—the medical, military, and economic value—of research. This is the greatest of the great achievements of the war.

The savant in the laboratory and the clinician in the hospital have been wedded at the bedside in the bonds of a scientific fellowship, never before so welcome and never before so fruitful for the good of mankind.

Fortunately, in our medical schools, our institutes of research, and the new Red Cross laboratories at Geneva, this wonderful work will be still further developed.

3. *Professional Uprightness.*—In one respect, I have an exultant pride in the honor and uprightness of our ancient guild. With our women patients, our honor is always at stake. We see them alone and we trust them with that which we hold as dear as life itself. On the other hand, they give their honor into our hands with many and unusual temptations. Yet, how rare it is that a medical man is even accused of wrongdoing! Among the hundreds of thousands in many lands (and there are black sheep in every flock), the lapses from honorable and upright conduct are so few that even its possibility scarcely ever occurs to any woman as the door of the consulting room is closed.

The wonder is that among so many women patients there are not more adventuresses who would endeavor to blackmail us. The community trusts us as no other class of men is trusted, and we, God be thanked, have proven ourselves worthy of their trust.

We are a profession, as distinguished from a trade. In the latter there is always a ready means of fixing values by the pound or the yard or by number. The services of our guild can never be weighed in the balance or be measured by length or breadth or number. We should never lower our standards.

A new remedy, a new splint or brace, or a new method of treatment, therefore, should be as free as the air we breathe, a new splint devised in Philadelphia should be as available in Paris, in Tokio, in Cape Town, or in Buenos Aires as in Philadelphia. A new remedy should be available for all doctors and all patients in all parts of the world. They should not be compelled to wait till they could get either the one or the other from Philadelphia or Paris or London, especially when, as often may be the case, to wait even a day may mean death or disability.

4. *Venereal Diseases.*—Never before has this menace to the health and general welfare of the community been so generally appreciated by the public as well as by our profession as during and because of the war. What injures the individual injures the state. Hence the most extraordinary and extraordinarily successful campaign against venereal diseases inaugurated by the war should be zealously continued, now that the war is over.

Ever since the fifteenth century, increased and disseminated by war, syphilis has always been a scourge both to armies and to the population among whom they were encamped. But in the great war the incidence both of syphilis and of gonorrhœa immediately dropped to a startling degree the moment that the men came under army discipline and with the

safeguards which surrounded each camp. By these same means the health of the community was protected. The incidence of venereal diseases in the Army was far below that in the civil community.

Now that the armies have been demobilized, the lessons taught the men by lectures and especially by the cinema films, it is hoped, will not be forgotten but will still act as deterrents.

But after all, the only sure and permanent deterrent will be a change in our moral attitude, our moral standards. There must be a "change of heart" to make permanent a change of conduct.

Our young men must be convinced that at the marriage altar where a new family is founded, the bridegroom should be as clean and as pure as the bride. He should realize his responsibility in the conservation of his wife's health and in the creation of strong and healthy children.

A single standard of sexual morality is the only righteous and just standard. It should be just as disgraceful in the judgment of the men and women in the community for a man to have a mistress, as for a woman to have a privileged lover. Social ostracism, now visited only upon the woman, should be meted out equally to the man.

We—we doctors, I mean—who especially well know all the evils not only to the husband, but to the wife and to their children—would not willingly give our daughters to men who are victims of gonorrhœa or of syphilis. Surely, those of us who have sons would be unwilling for them to marry young women already besmirched. Shall our daughters be less jealously guarded than our sons? You know what it would be for your son or your daughter to have wretched, syphilitic children, doomed to a life of misery, to whom death would be a blessing and the tomb a welcome relief.

In the United States, impressed especially by the gravity of the venereal peril, eleven states of the forty-eight have passed laws to safeguard the community from the perils of transmissible and especially of venereal diseases in the marriage relation, in order to safeguard the health of the wives and children. The requirements vary all the way from a medical certificate, after a physical examination, made shortly before marriage, to a mere affidavit of one or both parties that they are free from any venereal or other communicable disease which would impair the health of the children born of such a union. The penalty is fine or imprisonment or both.

I have made a number of personal inquiries from lawyers of the best standing as to how these laws really are working. Some have been enacted too recently to enable any reliable judgment to be formed as to their value; some are ineffective, or ineffectively enforced; some are evaded by marriage in an adjacent state having no such law. Those that are really enforceable and also enforced are of value, in the judgment of health officials and lawyers, partly because their penalties act as deterrents but chiefly because of their moral and educational value.

This movement is sure to grow. I venture the opinion that as the facts as to these diseases and the requirements of the laws become more widely known, especially among young women about to marry, they will be more and more insisted upon by the young women themselves or by their parents.[1]

Proper education in sexual matters should be given to young boys and girls by their parents or by physicians. They should be taught the facts of reproduction in a clean and pure way before they acquire such knowledge by the often filthy teaching from boys and girls a little older than themselves.

5. *Our Altruism.*—We are the only *self-destructive* profession. In unselfish devotion to the welfare of the community, in the battle royal against disease, in the fight for pure water and pure milk and wholesome housing—in a word, in preventive medicine, I glory in the fact that we doctors are always the leaders.

Every disease that is abated, such as smallpox, typhoid, typhus, diphtheria, dysentery, and such like, has had its chief adversary in our profession. A single epidemic of smallpox in a single city will bring more actual revenue to the doctors than a quarter of a century of vaccination, but we are the vanguard in insisting upon vaccination in order to stop this procession of death. We lead the fight for pure water and pure milk to prevent epidemics of typhoid—again wholly to our own financial detriment.

This twentieth century will be only a few years older when yellow fever, one of the former great scourges of the Western Hemisphere, will be actually entirely blotted out of existence. This will be the first instance ever known of such a wonderful miracle in the history of the human race. The glory of it belongs to our profession—to Carlos Finlay, to Walter Reed and his associates, and to that prince of sanitarians, General William C. Gorgas, of the United States Army, whose world-lamented death has occurred since these lines were written.

All honor, then, to the men of our guild for unselfish devotion to the health of the state.

6. *Abstention from Alcohol.*—I have no doubt there will be a greater diversity of opinion on this point than on any other. I can only state my own opinion and give the reasons why I hold it. What I shall say has no relation to the use of alcohol as a medicine but wholly to its use as a beverage.

Without doubt, the least prejudiced conclusion, based upon the results obtained by the most scientific and most rigid experimental investigation, is that

[1] The best two publications to be consulted are, "American Marriage Laws in Their Social Aspects," by Fred. S. Hall and Elizabeth W. Brooke, Russell Sage Foundation, New York, 1919, and in a careful study in the Social Hygiene for April, 1920, 105 West 40th Street, New York City, by Mr. Bernard C. Roloff, Executive Secretary of the Illinois Social Hygiene League.

of Dr. Raymond Dodge and Dr. Francis G. Benedict, head of the Carnegie Nutrition Laboratory in Boston. His conclusion is tersely stated in these words: "Any use of alcohol, even though it be occasional, must be regarded as contrary to scientific teachings."[2] Miles,[3] experimenting on doses of 30 c.c. of absolute alcohol, suitably diluted, says that 27 cases out of 30, *i.e.*, 90 per cent., showed inferior functioning after this dose. Kraepelin[4] and Mitander[5] demonstrated greater or less losses of efficiency in the target practice of experienced marksmen after small doses, such as 30 to 40 c.c., of alcohol.

While these results are attained by scientific experiments of great accuracy in a small number of men, the results of prohibition in the United States and later of the adoption of the Prohibition Amendment to the Constitution, demonstrate the extraordinarily beneficial results even within the few months since its adoption. The fact that private stocks of liquor are not yet exhausted, and that the machinery for the effective enforcement of the law is as yet incomplete, and therefore that liquor can be obtained if one can pay the higher prices now charged only add to the strength of the argument from these results.

For actual conditions in New York City I have to thank Mr. Bird S. Coler, Commissioner of the Department of Public Welfare, and Dr. John Fitzgerald, temporarily in charge of Mr. Coler's office. They have most courteously given me complete information covering nine large municipal hospitals, and one even more valuable source of information, a large municipal lodging house.

Of course, I can only epitomize the facts and opinions of the medical officers in charge.

In the lodging house the admissions for January, February, and March, 1919, under license numbered 22,350. In the corresponding months for 1920 under prohibition, they were 4607.[6] Not only were the results so remarkable in numbers, but "the applicants were better, cleaner, and healthier than formerly." Intoxicated applicants were rare, while "formerly we were obliged to call a policeman nightly to have the drunks removed." The employees were giving better care to their personal appearance and were saving money. "I have met men on the street," writes the superintendent, "who were formerly regular lodgers and was surprised at their neat and clean appearance. They are working steadily and buying clothes instead of drink."

Among the hospitals the general result was a largely decreased num-

[2] Scientific Aspects of Moderate Drinking, Boston Med. and Surg. Journal, Feb. 18, 1904.

[3] Effect of Alcohol on Psycho-Physiological Functions, Carnegie Institution Publication No. 216, 1918.

[4] Münch. med. Wochnr., 1899, No. 42.

[5] Bericht des 10. Int. Kongr. gegen den Alkohol, Budapest, 1905, pp. 193–204.

[6] The report for March being rendered on the 16th, I added the average for the remaining five days.

ber of admissions, especially for intoxication and delirium tremens. Also, again, among the employees there was great improvement. One report says of them that some of the former worst offenders were opening bank accounts.

The Psychopathic Ward at Bellevue Hospital, of New York City, handles more alcoholics of the vagrant and poor class than any other hospital. Dr. M. S. Gregory, the Director of that ward, writes that in January and February, 1920, instead of 400 to 500 cases a month, there were only one or two a day so that the ward was *abolished!* As soon as the lax administration of the law set in, the number increased to five or six or even ten a day. This, however, was a much smaller number than before prohibition.

In Philadelphia, the House of Correction, in which the most of the cases of vagrancy and alcoholism are treated, instead of a population of over 2000 before prohibition, has a population of only about 400 to 500 since prohibition became effective. In the first four months of 1920, the savings by reason of fewer employees, less wages, less food, and other expenditures, were sufficient to pay all the expenses of the entire Department of Public Welfare for the remaining eight months of the year.[1]

A similar diminution of the number of inmates in the County Prison in Philadelphia has raised the question whether the House of Correction and the County Prison could not be combined with consequent large economies. Four adjoining counties in Massachusetts are about to abolish three jails as the one remaining jail can accommodate all the prisoners of the four counties.

In Philadelphia in the first six months of 1919, under license, there were 17,114 arrests for intoxication. In the last six months under war prohibition, the number was 6509, a decrease of 62 per cent.

In the alcoholic department of the Almshouse (Philadelphia City Hospital) the admissions in the last six months of 1917 and 1918, *i.e.*, before war prohibition, were 1470 and 1184, respectively. In the same period in 1919 under war prohibition, there were only 276, a decrease of 77½ per cent.

In Massachusetts, Mr. H. C. Parsons, Deputy Commissioner for Probation for the whole state, as a result of the first year of prohibition, reports that during the first five months of 1919, under license, there were 34,176 arrests for drunkenness. In the corresponding months of 1920, under prohibition, there were only 10,324—a diminution of practically 70 per cent.

Judge Cabot, of the Juvenile Court, states that the family relations are greatly improved. The parents, instead of neglecting their homes, are trying to make them attractive to live in, and instead of spending their time and money in the saloons, are taking their children to the cinema (" movies ") and to church.

[1] Personal statement to me by Hon. E. L. Tustin, Director of Public Welfare, in Philadelphia.

Many rural courts have no culprits before them for days and even weeks. During the war the great improvement in social conditions following the prohibition of vodka in Russia told the same story.

I need not urge on this audience the argument that alcohol is the most powerful and most frequent cause of sexual immorality and its attendant venereal diseases, to say nothing of the evil effects of the alcohol itself.

Whatever may be the conclusions of scientific experiment on the effects of alcohol, the huge experiments on the millions of human beings in the United States as shown above and in Russia seem to me to be conclusive that total abstention from alcohol results in less drunkenness, less poverty, less crime, less disease, fewer accidents, and smaller expense to the city and the state. If so, is it not our duty as a profession to urge total abstinence from the standpoint of the health and the general welfare of the entire community?

As the Supreme Court of the United States has decided that the Eighteenth, the Prohibition Amendment, is constitutional, and is, therefore, the supreme law of the land, it is proper to call attention to the serious effect that prohibition will have upon industry and trade.

Under prohibition undoubtedly fewer hours are lost by workingmen and fewer industrial accidents occur, since both are largely due to alcoholic excesses. In the modern keen competition for the markets of the world, a drinkless nation will thus have a most important economic advantage over a drinking nation, both in the better character of its workmen and in the more uninterrupted hours of labor. Hence the output of its products will be greatly increased and the cost lessened.[1]

7. *Bravery.*—In combating great plagues, when and where have the doctors been cowards? Where have they run away to gain safety for themselves, leaving the victims of disease to suffer and die unattended?

Let Serbia and Poland respond. Let the southern cities in the United States—Norfolk, Memphis, New Orleans—so often devastated by yellow fever, reply. In Europe and America, let the cities which have been decimated by cholera give answer.

The case needs no argument. It is confidently committed to the jury of the world without instructions from any judge. The verdict is and has always been, "Guilty of the highest bravery known among men." Without the gorgeous trappings of war, without the beating of drums and the blare of trumpets, with only "Duty" as a watchword, and God-like compassion as a motive, they have ministered to the sick and dying and only too often have been among the slain.

8. Finally, we stand for pure and undefiled religion as the surest guide for the present and the surest hope for the future. Observe, I say, not theology, which is a separating, a sundering force, but religion, which is even etymologically that which binds together, and morally is the supreme hope of the world.

[1] By accident this and the preceding paragraph were omitted in the French translation in the Gazette des Hôpitaux of July 17, 1920.

BE STRONG

Be strong!
We are not here to play, to dream, to drift;
We have hard work to do, and loads to lift.
Shun not the struggle; face it. 'Tis God's gift.

Be strong!
Say not the days are evil—who's to blame?
And fold the hands and acquiesce—O shame!
Stand up, speak out, and bravely, in God's name.

Be strong!
It matters not how deep intrenched the wrong,
How hard the battle goes, the day, how long;
Faint not, fight on! To-morrow comes the song.

—Maltbie D. Babcock.

THE TREATMENT OF CHRONIC EMPYEMA *

By Th. Tuffier, M.D.
of Paris, France

By chronic empyema is meant a suppuration of the pleura with no tendency to spontaneous cure. This chronic character in itself is always grave. The frequency of the condition has diminished since our better knowledge of the manner of treating acute infections. From the month of August, 1914, to the month of December, 1919, I operated upon 91 acute and chronic suppurations of the pleuræ.

I. TREATMENT OF ACUTE SUPPURATIONS—PREVENTIVE TREATMENT OF CHRONIC SUPPURATION

1. One must first determine the bacteriologic nature of the effusion. Exploratory puncture is here of value. It is, in fact, of the first importance. Pneumococcic pleurisies are usually mild and are often cured by simple aspiration, while streptococcic pleurisies are grave and most often require thoracotomy.

2. If repeated punctures leave a residuum as shown by radioscopy, thoracotomy is done at the point of election in the posterior axillary line under local anæsthesia.

3. Evacuation of effusions and disinfection of the pleura follow. In certain cases the pleura can be closed, *completely and immediately*. Example, 3 cases (2 pneumococcic with cure, 1 staphylococcic with return of suppuration and secondary disinfection with Dakin solution, secondary closure and cure). In most cases we prefer drainage by siphon after thoracotomy. This is the most simple procedure. Radioscopic examination shows progressive diminution of the pleuritic process. For bad conditions persisting in spite of drainage (as to pulse, temperature, and general condition), and a continued large infected cavity in the pleura we proceed thus: Extensive thoracotomy and pleuroscopy under local anæsthesia permitting a view of the form and dimensions of the pleuritic cavity; disinfection by the Dakin method, numerous Carrel tubes placed in all corners of the cavity. If a broncho-pleural fistula exists, discontinuous injections of oxygen are substituted for the Dakin solution. When the culture curve has reached zero and a dry compress placed at the opening of the cavity remains dry for twenty-four hours, complete closure is made of the surgical orifice, resection of the edges of the fistula, tamponing of the pleura to avoid discharge of blood into the interior, and complete suture of the wound. One thus transforms the former pyothorax into an

* Read before the American Surgical Association, May 3, 1920.

aseptic pneumothorax which is spontaneously cured by bringing back the parietal pleura into contact with the lung.

The volumes of the operated cavities were as follows: 6 had a content of 2 to 3 litres; 5 had a content of 1 to 2 litres; 7 cases showed enormous cavities, exact size not given; 2 cases showed rapid cure; 7 cases were lost, all of acute pleurisy medically treated, this variety being always more grave than suppurating and operated pleurisy.

With regard to the time of thoracotomy, of the 7 patients succumbing after intervention 5 were operated early after the pleural effusion had

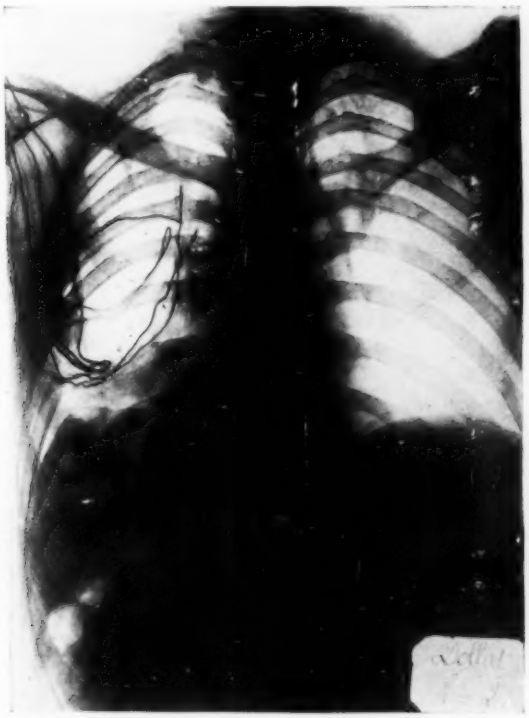

FIG. 1.—Use of armed rubber tubes for exploratory purposes.

occurred, when suppuration had scarcely begun and *general* evidences of infection were intense. All 5 cases were streptococcic. Case XII was cyanosed, with arterial hypotension of marked degree. Case XX after a three-months pregnancy presented the same symptoms with intense dyspnœa and oliguria. Case XXIII added to these symptoms an œdema of the thoracic wall. Patients affected with purulent pleurisy recent in origin or with post-grippal or originally purulent pleurisy were ill but a few days (eight to fifteen at most). Onset was sudden and all cases presented the septicæmic type characterized by more or less cyanosis of the face and extremities, dyspnœa whose intensity was more in relation to the toxæmia than with the quantity of pleural effusion, and pharyngo-laryngeal

symptoms. To these phenomena of intoxication were added in three of the cases (XXII, XXIV, XXV) external evidences of the general infection (facial erysipelas, diffuse phlegmon, erysipelas of the costal wall on the side affected) which developed with the greatest rapidity.

Thoracentesis done before operation brought no relief to these cases. The abundant effusion, invading the entire pleura, was an ill-looking, dirty-yellow, sero-sanguineous liquid, often of putrid odor and associated with adhesions of greater or less density.

In Case XXIV we were able to verify the septicæmic character of the

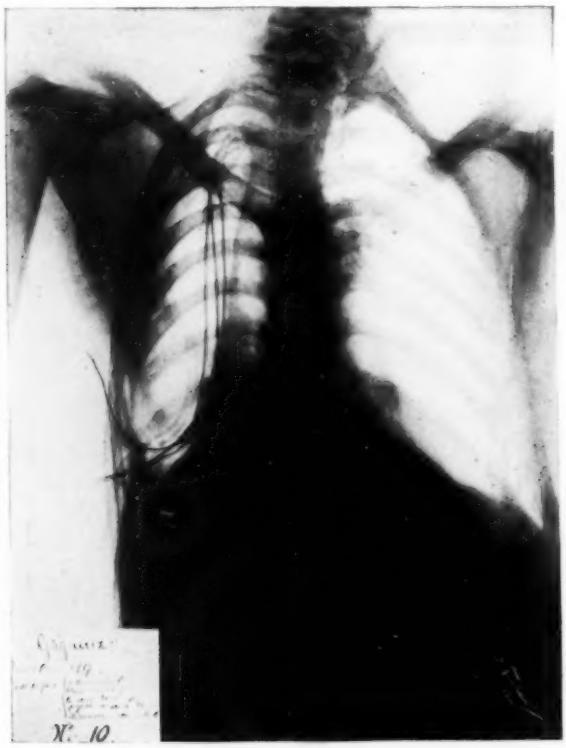

FIG. 2.—Use of armed rubber tubes for purposes of exploration. (Gagneux.)

infection by spleen changes (enormous size and doughy consistence), the pleurisy being thus but a local manifestation of the general condition. In these five cases the blood culture was positive for streptococcus. Another of the cases (Case XXII) cured, is of the same kind. In these the operative intervention was later, and we repeated several times before and after operation intravenous injections of antistreptococcic serum.

Analysis of the events following intervention at the height of the infection prove that the pleural effusion was only an epiphenomenon and that it was the general infection which was in no wise modified by the

evacuation of the effusion which brought these patients to us. I will not venture to draw the conclusion that one must temporize in the treatment of suppurating pleurisies and to wait until they play the rôle of operation abscess before being incised. At all events, these facts plead against immediate thoracotomy in the non-surgical pleurisies which concern us. If the effusion causes untoward conditions, remedy of it by puncture is better than a more complete operation.

Notwithstanding other treatment, *four acute cases became chronic,* causation being as follows:

Pleural diverticula and broncho-pleural fistulæ rendered disinfection im-

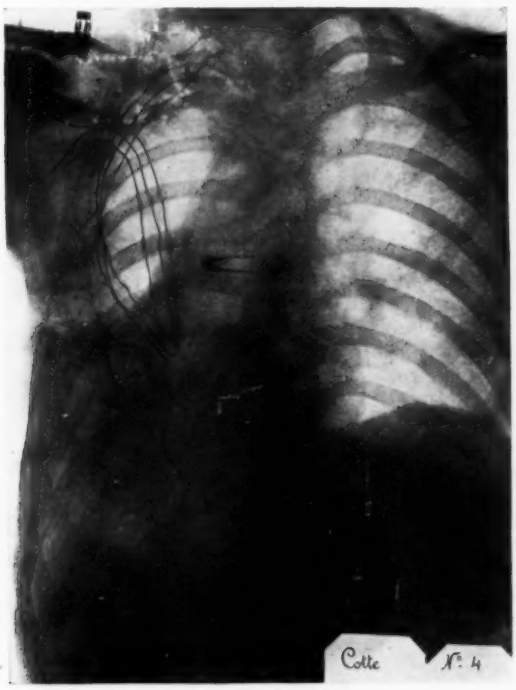

FIG. 3.—Use of armed rubber tubes for purpose of exploration. (Cotte.)

possible. One could easily locate the seat of a chronic infection by seeking out the situation of the microbic attack. When in a pleural cavity that appeared to be aseptic one sought in various regions for the microbic focus, one found a single and persistent septic cavity. By means of electric pleuroscopy one thus diagnoses a diverticulum of the pleura which is not reached by the antiseptic solutions injected and which empties itself very completely.

Bronchial fistulæ are equally factors in producing chronic conditions because of the septic features which they entail. I have noticed two effects of this sort of infection, the first being a necrosed bronchial

cartilage, the course and termination of which were followed under conditions described below, *viz.*:

CASE XI.—The patient before entering our service had spent a month being treated, and several thoracenteses had been made. Some days before operation injection of methylene blue was made into the pleura, with the production of attacks of a minor grade of vomiting ("spitting blue"). After operative intervention disinfection of the pleura by Dakin's solution was very badly borne and induced incessant coughing. Pleuroscopy then revealed, on the pulmonary pleura at the level of the interlobular fissure, a little

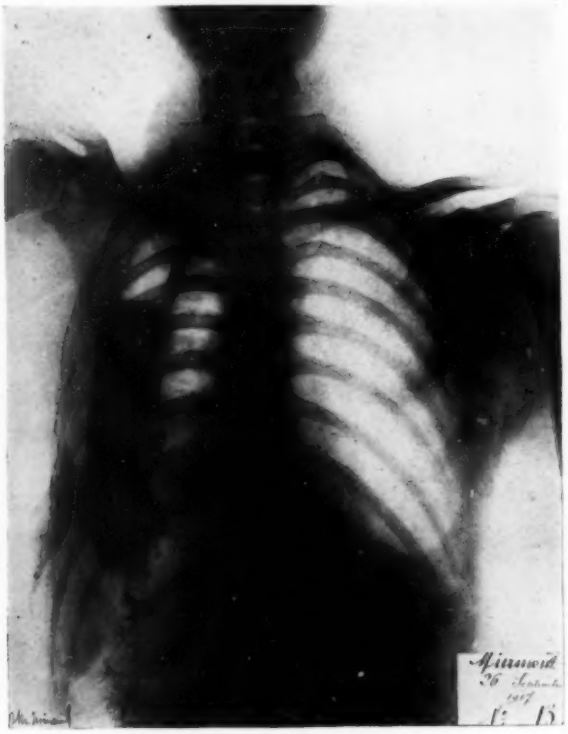

FIG. 4.—Empyemic cavity filled with bismuth for purposes of exploration.

sphacelated plaque, grayish-green in color, irregular, and about the size of a dime. It could not be detached by the forceps and contact with it provoked pain and cough.

Instillations of Dakin's solution at this point determined diagnosis of an eschar and probable bronchial fistula (cough and discharge of Dakin's solution from the mouth). From December 18, 1918, to January 22, 1919, discontinuous insufflations of oxygen were resorted to in order to disinfect the pleura, the Dakin's solution not being tolerated. The bronchial eschar becoming then more and more

limited by granulating pleura, disinfection with Dakin's solution was resumed. By February 9th the eschar was reduced to the size of a pea and no further signs were caused by it.

There are also anatomic or pathologic diverticula which one can diagnose *de visu* by electric illumination of the pleura. Such diverticula are described in Case XII.

When bronchial fistulæ are recent and without necrosis of cartilage, they do not embarrass closure of the pleura. I have operated two broncho-

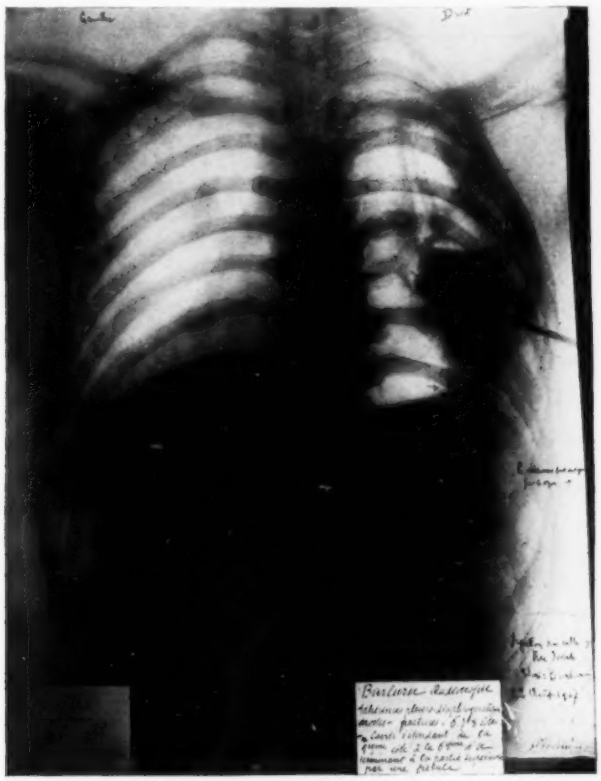

FIG. 5.—Empyemic cavity filled with bismuth for purposes of exploration.

pleural fistulæ of some weeks' duration only and after the opening of a pleurisy into the bronchi before operation. The cavity was asepticised, the costal orifice closed, and the patient cured as simply as if he had never had a fistula.

There is another variety of chronic fistula especially grave, ending generally in gangrenous processes, following pulmonary injury. Here the orifice is located at the bottom of the pleural cavity, and one clearly sees a suppuration which nothing can control. Cough is frequent, expectoration of pus more or less abundant, no disinfectant can stop the infection. In such cases I have tried to close the costal wall only to fail.

The second effect referred to is that of broncho-pleural fistula with bronchial ectasia around the fistula. In removing adhesions about the fistula in a case of this kind I found a series of cavities varying from the volume of a large pea to that of a filbert, containing pus and constituting areolæ-like veritable honeycomb. In short, such a case shows a bronchial focus, localized, and with pulmonary sclerosis. Incision and opening of these cavities are indicated, but are unsatisfactory. In one case still under treatment bronchial suppuration persisted. One must resort to extirpation of the pulmonary nidus by incision (partial pneumectomy) into

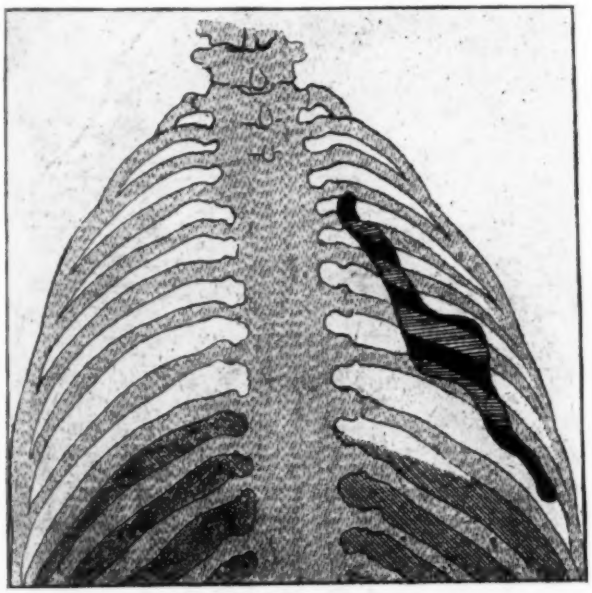

FIG. 6.—Showing empyemic cavity filled by an injection of bismuth.

healthy tissue. The bronchial fistula may become permanent by direct continuation with the thoracic wall of a small orifice which closes during expiration. An example is seen in a case which I operated during childhood, twenty-five years ago, the fistula persisting without the least embarrassment from infection. It has always resisted every freshly attempted treatment.

Small abscesses may be remarked in the visceral pleura, visible by electric pleuroscopy and being capable of retarding cure. At their site the serous membrane was markedly thinned, having the appearance of onion skin, ready to break, and consequently leaving an ulceration or perhaps a bronchial fistula, splendid avenue of communication for the transfer of infection between the pulmonary tissue and the pleura.

In Cases XXVI and XXVIII we diagnosed, by pleuroscopy, similar ulcerations located at the middle of the median lobe of the lung. In fact, they were multiple intrapleural abscesses as in Case XXIII.

Whatever the cause of chronicity, once induced it requires a long and difficult treatment. The cavity may be indurated, fixed, fibrous, inelastic, or completely calcareous, with thick walls. I have operated cases lined with calcareous plaques like oyster shells (Tuffier and Gy, *Revue de Chirurgie*, 1907, pp. 329–346). To fill this cavity the lung must return to its contact with the pleural membrane or the pleura must advance to a contact with the retracted lung. The ill-advised operation of Estlander consisted in obliterating the costal opening, which permitted the skin and muscles to heal before the lung was in good condition; it meant abolition of pulmon-

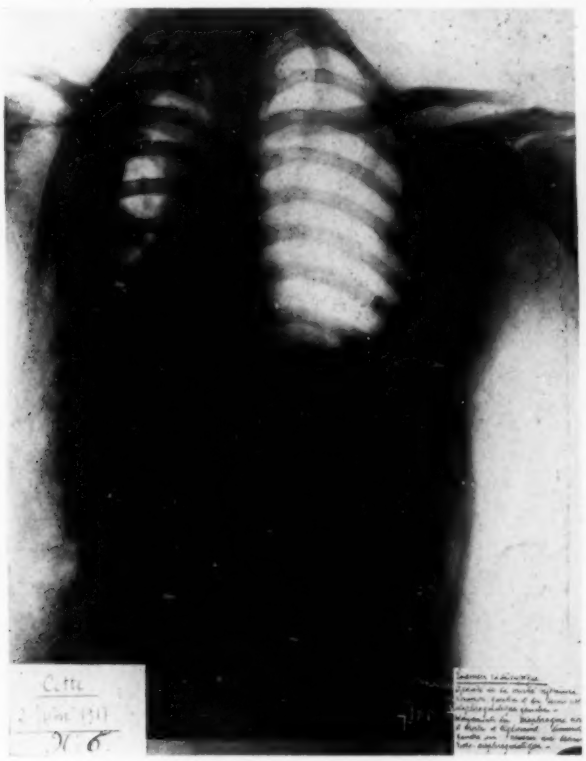

FIG. 7.—Showing radio-opacity in the lower half of the left lung. (Cotte, June 2, 1917.)

ary function in the affected region, with all the trouble incident to it. Our object is precisely the contrary. It consists in every case where possible in removing the pleural shell to permit the lung to return to its proper position in the thoracic cage, intact or nearly so, continuing a nearly normal function.

II. TREATMENT OF CHRONIC EMPYEMAS, RECENT AND OLD

Cases are those of pleural fistula. Treatment should always be preceded by a methodical exploration of the cavity, which includes noting its extent and form and examining the pulmonary mobility during expiration

and inspiration and the effort necessary, the degree of pulmonary expansion being thus ascertained. The resulting information indicates application of one of two methods, *viz.:* Disinfection of the cavity and respiratory exercise; or, closing of the surgical wound by the method of Depage and Tuffier. If the cavity is intractable, pleuro-pulmonary decortication, partial or total, may be practised.

Exploration.—(*a*) Radioscopy and radiography. The pleural fistula is often narrowed, leading to a cavity; radiography permits exact knowledge of its form and extent. By introducing several rubber tubes carry-

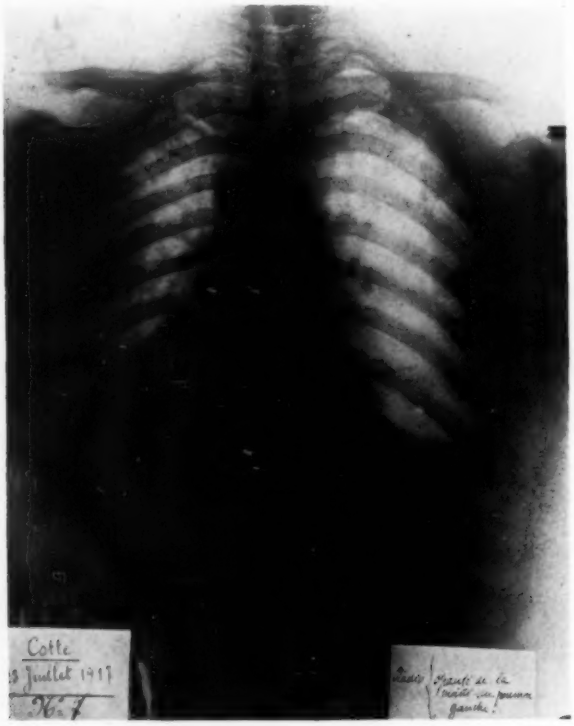

FIG. 8.—Showing radio-opacity in the middle of the left lung. (Cotte, July 8, 1917.)

ing wire, one ascertains extent, direction, and form (Figs. 1, 2, and 3). If this method is insufficient, injection is made of a paste of bismuth or barium (Figs. 4, 5, and 6). Radioscopy (Figs. 7 and 8) should show the extent of the cavity during inspiration and expiration, and the degree of effort. It permits thus a study of pulmonary expansion, one learns the minimum volume of the cavity and the play of the lung antero-posteriorly and laterally, and therefore one knows the location of points of adhesions which must be attacked. I have noticed cases where the cavity during forced expiration disappeared completely, prognosis being especially favorable.

Radioscopy permits at the same time to follow the involution and diminution of the cavity during disinfection. Respiratory exercises with forced expiration are continued during the entire term of exploration and disinfection.

(*b*) Pleuroscopy. This enables investigation of the obstacles to contact of the lung with the thoracic wall. If the fistula is large, one does pleuroscopy through the orifice as in cystoscopy. Essentials to be noted are color of the cavity, surface of its walls, irregularities, diverticula, bronchial fistulæ, and the regions suppurating.

(*c*) Bacteriologic and microscopic examination. This establishes the

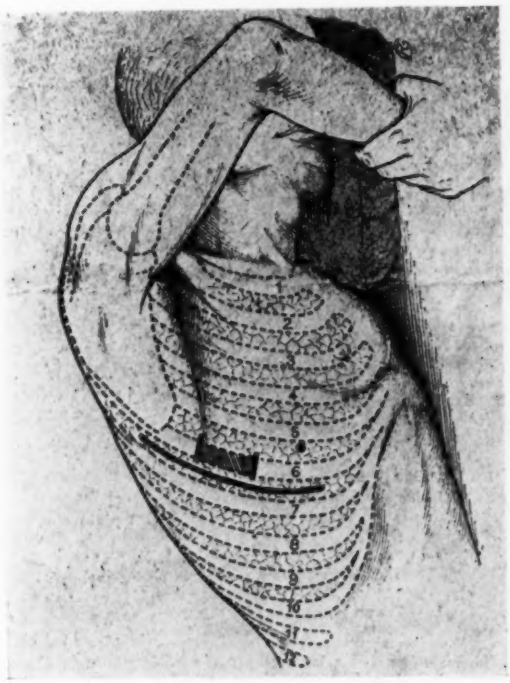

FIG. 9.—Incision in the intercostal space.

number and nature of the bacteria, their location, and gives the base of the culture curve during disinfection.

(*d*) Surgical exploration. This may be followed immediately by the surgical treatment. Method: Local or general anæsthesia; lighting by the forehead lamp; wide thoracotomy following along the intercostal space (Fig. 9) corresponding to the fistula, resection of its borders and of the bony callus which surrounds and results from the fusion of the ribs; removal of adhesions; separation of the edges of the cavity by means of a special instrument (separator). One thus learns the extent of the cavity and the consistence of its walls in different regions. Three forms of pathology may be found: (1) A fistulous tract sometimes very long, extending

from the base of the thorax to the upper ribs; (2) a regular cavity with considerable retraction of the lung, always difficult to cure; (3) a fissured cavity, narrow but with a very long principal diameter, often directed from above downward and backward, which diminishes considerably during respiratory effort. These cases may present diverticula of which the most difficult of cure are those which form pockets, bilobed or multilobed, with constrictions between each lobe. If the cavity is small and not greatly infected, one can attempt immediate pleuro-pulmonary decortication or the resections necessary to a cure. We thus treated eight cases (two acute, six chronic), but this exploration should most often be followed by chemical disinfection of the cavity.

(*e*) Disinfection of the cavity. I prefer the Carrel-Dakin method when

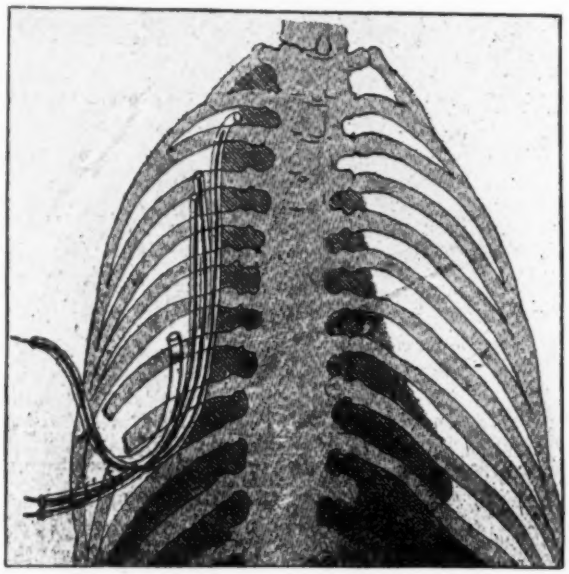

FIG. 10.—Rubber tubes, armed, introduced into the fistula for purposes of disinfection.

possible. Rubber tubes are armed with silver wire, very fine and pliable, and placed in such a fashion as constantly to irrigate the cavity and all diverticula (Figs. 10 and 11; see also Figs. 1, 2, and 3). This procedure is indispensable and the essential of the method. It is necessary to have several tubes and to place the patient in a position permitting the antiseptic liquid to have access to the diverticula. Disinfection may be more or less rapid, but it is often very slow. Its progress is mapped by curves (Figs. 12, 13, 14, and 15). This series shows some of these difficulties.

This procedure may be impracticable if there is a broncho-pleural fistula. Irrigation produces cough and a chlorine taste in the mouth which cannot be borne. Therefore, before placing the tubes, introduce into the pleural cavity a wick of gauze to tampon the bronchial orifice and

prevent flow of the liquid to the mouth. At the time of injection one can also place the patient in lateral decubitus, lying upon the fistula. These means are often insufficient at the beginning of treatment; later the liquid no longer passes into the bronchi, probably as a result of spontaneous narrowing of the broncho-pleural orifice, and disinfection becomes easy.

When all these means fail, I replace them by continuous or discontinuous aëration with oxygen gas, passed into all the recesses of the cavity as the Dakin liquid is distributed. This method was applied in five cases. Bacteriologic examination of these cases showed three with

FIG. 11.—Use of armed rubber tubes for purpose of disinfection. (Case of Cotte, see figs. 3, 7, 8.)

streptococcus alone, one associated staphylococcus, diplococcus, streptococcus, coccidia, and a mononucleated organism, and one with no bacterial finding. All five patients were cured.

Naturally this disinfection is often difficult and stubborn. The cause must be sought. The location of the bacteria explains in certain cases the resistance of the septic process to treatment, for example, in case of a pleural diverticulum not reached by the disinfectant solution and which must be located and treated, or again, with a bronchial fistula demanding oxygen or tampon with a compress before employing the Dakin solution; the culture curve may be irregular, as may be readily noted. Two cases

were operated in two stages; I first closed off the aseptic region and later instituted disinfection of infected locations. During the stage of disinfection respiratory exercises were continued as the cavity grew smaller. Extent of the treated cavities:

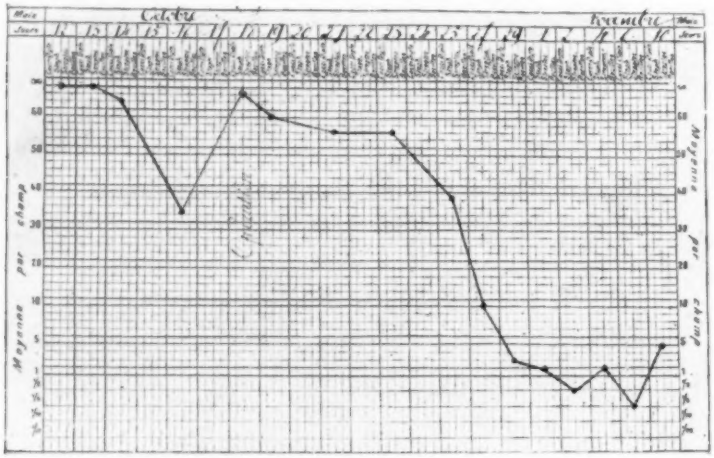

FIG. 12.—Microbe curve: showing progressive diminution of infection under treatment.

Content before operation .... 360 c.c.	Content at time of closure .... 150 c.c.
Content before operation .... 141 c.c.	Content at time of closure .... 70 c.c.
Content before operation .... 45 c.c.	Content at time of closure .... 8 c.c.
Content before operation .... 360 c.c.	Content at time of closure .... 60 c.c.
Content before operation .... 125 c.c.	Content at time of closure .... 25 c.c.
Content before operation .... 65 c.c.	Content at time of closure .... 20 c.c.
Content before operation .... 175 c.c.	Content at time of closure .... 15 c.c.

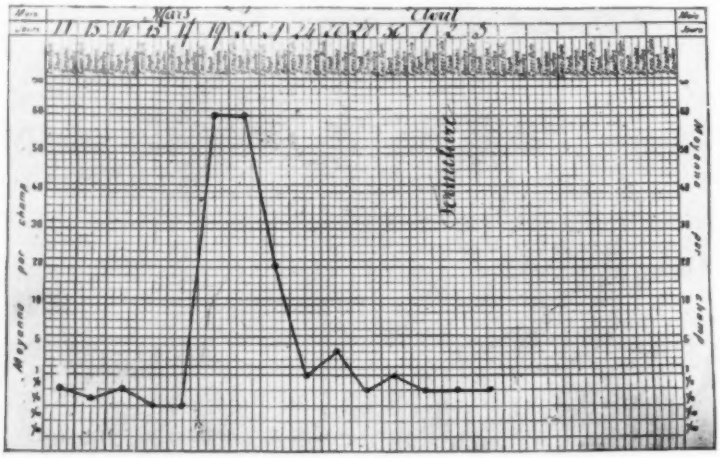

FIG. 13.—Microbic curve, showing effect of drainage and disinfection.

Early disinfection is essential; pulmonary decortication formerly done by Delorme's method nearly always failed. Before closure two condi-

tions are important: (1) The culture curve must read zero, streptococci being absent; (2) the pleura, without further application of Dakin solution and dressed only by sterile gauze, should not secrete. One can then

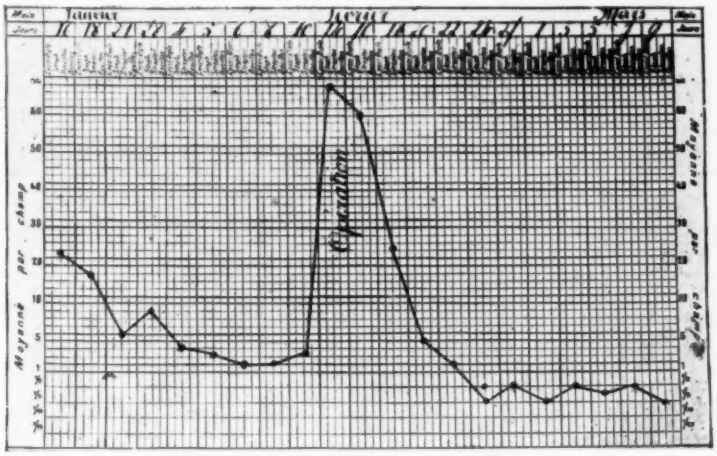

FIG. 14.—Microbic curve, showing effect of drainage and disinfection.

close the *parietal orifice* with no further concern about the cavity (Depage-Tuffier) or perform pleuro-pulmonary *decortication*. In cases where decortication alone is applicable, I operate before securing total disinfection.

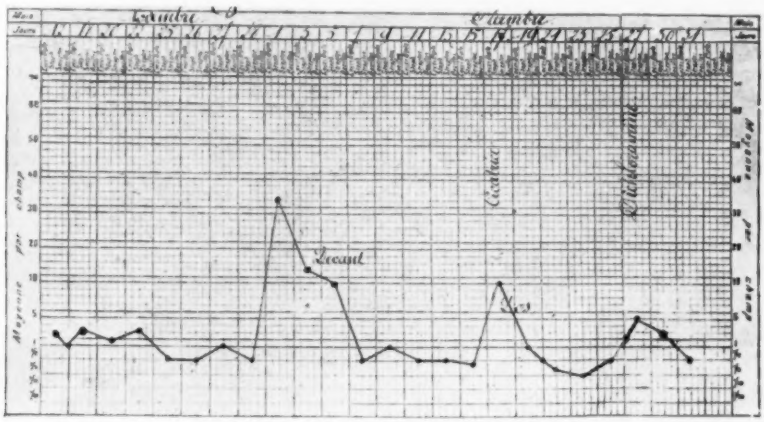

FIG. 15.—Microbe curve, showing average number of organisms in the microscopic field.

The Depage-Tuffier Method.—The culture curve reading zero and the cavity no longer secreting, the surgical incision is closed.

1. Introduce aseptically into the pleura a narrow wick, in order to prevent entrance or stay of blood within the pleural cavity during the operation.

2. Under local anæsthesia the edges of the orifice are resected throughout its depth and down to healthy tissue, all incisions are tamponed and

perfect hæmostasis of the wound is secured. Closing is done either in one plane with silkworm gut, or in two planes, the deeper with catgut and the superficial with silkworm. Closure is complete with aseptic dressing applied.

This method is indicated in all cases where the cavity is reducible by the respiratory effort, even in recent cases with uninfected bronchial fistula. Sutures are removed on the seventh day.

Should there be a bloody effusion into the pleura during or after the operation, I insert a bundle of silkworm threads to drain the cavity for twenty-four hours. One can follow the regression of the cavity by radios-

Cotte Joseph.
12 Novembre 1916 .. Blessure
22 Février 1917 .. Entrée Brauyou
27 " " Fistule
7 Mars " Opération
20 " " Fermeture
27 " " Réouverture
23 Avril " Extraction projectile
22 Mai " Stérile .. Future
9 Juin " fistule
11 Juin " Drain
21 Juin " Fermeture

FIG. 16.—Syllabus of the various stages in the treatment of a case of chronic pleuritis and fistule following a perforating gunshot wound of the thorax.

copy and auscultation. Usually resorption appears complete when the dressing is removed on the eighth day. If suppuration again complicates, I open the cavity anew.

Pleuro-pulmonary Decortication.—This operation was made in nine intractable cases, seven with total decortication and two with partial decortication. The fistula had been present two hundred and eighty days in the non-surgical cases and ninety-three days in the traumatic cases. Cavities invariably contained streptococci. The period of disinfection averaged thirty-three days for the non-surgical cases, forty-three days for the surgical cases. The method is the method of election in old and obstinate cases with cavities indurated and not reducible by

respiration. It includes two stages: (1) Thoracotomy with wide exploration, and (2) decortication, complete or incomplete, total or partial.

Exploration is made by thoracotomy. Resection is made of the edges of the fistula and of the osseous plaques often due to the fusion of the ends of sectioned ribs. Wide separation, always difficult, of the surgical in-

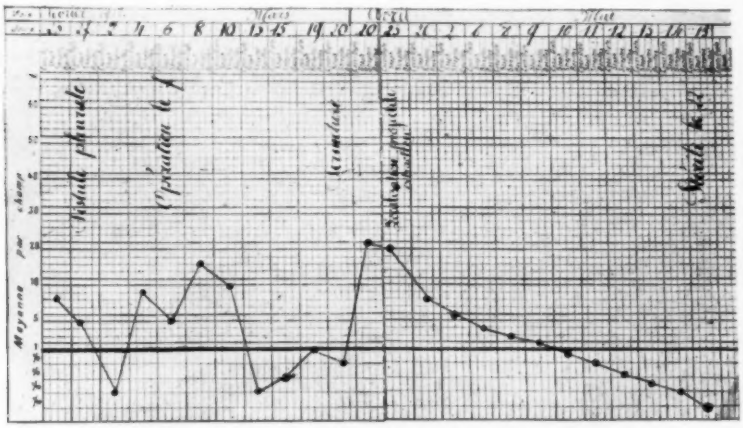

FIG. 17.—Microbic curve in the case of Cotte. (See Fig. 16.)

cision and the laying bare of all recesses and the entire cavity, are practised. If prior disinfection of the cavity is thus obtained, one continues with the decortication. If pulmonary decortication by Delorme's method has not been successful, it is only because it was not preceded by disin-

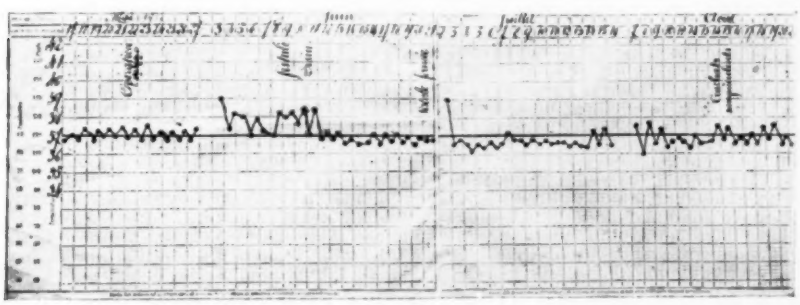

FIG. 18.—The later microbe curve in the case of Joseph Cotte (see Figs. 16 and 17), gunshot wound of lung.

fection of the pleural cavity, and in my early operations I always saw decortication followed by a new infection.

Operative Method—Total Decortication.—(1) Wide incision of the pleura is made to open the entire cavity thoroughly. (2) The cicatrix and osseous plaques about it are resected. Wide thoracotomy is done, beyond the limits of the cavity. Separation, by a separator, is made of the lips of the wound (Fig. 19). One ascertains the plane of pleuro-parietal cleavage at the level of the wound, this plane being often difficult to find.

Stripping of the pleuro-parietal region leading to the sinus of the cavity is done, here again amid grave difficulty in passing from the pleuro-parietal entrance to the pulmonary site. Adhesions are often intimate and thick at this level. The false pulmonary membrane is stripped off and here the difficulties are especially great. If, in some cases, the plane of pleuro-pulmonary cleavage is easy to find and follow, adhesions are usually so intimate that stripping of the false membrane results in penetration into pulmonary tissue with consequent bleeding. Total decortication has been successful with me only for cavities limited to the size of the two fists,

FIG. 19.—Dividing pleuro-parietal adhesions at the bottom of the cavity.

and I have never decortified an entire pleural cavity. Sometimes the process remains incomplete because of diverticula which cannot be reached or on account of deep adhesions involving the pericardium. Immediately after the removal of the false pulmonary membrane one sees the lung resume its expansion and again fill up the pleural cavity.

Pulmonary Decortication Alone.—In three cases, after wide pleural incision, I liberated the cavity at the level of the pleuro-pulmonary adhesion by attacking the false pulmonary membrane, which permitted the lung to expand. I did not trouble about the pleuro-parietal membranes. All these cases were cured.

Partial and Segmented Decortication.—Adhesions between the pulmonary false membrane and the lung are such that one can extirpate them only in sections. The periphery is incised at the union of the parietal and the pulmonary pleuræ to liberate the lung (Figs. 20 and 21). One then attacks the false membrane in different places where it appears likely to yield more readily, leaving it untouched where the fusion is especially intimate. Islands of adhesions are thus left, of greater or less thickness, on the surface of the lung. One then thins out, by dissection, the thickness of the adhesions up to the pulmonary surface. I do not

like to penetrate the pulmonary tissue, which always bleeds abundantly and thus constitutes an obstacle to cure.

In all these methods it may be necessary to resect one or two ribs more or less extensively. But in all cases preference is given to liberating the lung, so that it may fill the pleural cavity. One resects the skeleton only when expansion is absolutely impossible. If the raw surface left by decortication bleeds but little, I completely close the surgical wound in one or two planes. If there is a slight bloody oozing, I introduce a bundle of silkworm sutures to insure drainage for twenty-four hours. If the oozing is very abundant, I apply to the bleeding pulmonary surface a large wick to drain it, suturing completely at the end of twenty-four hours.

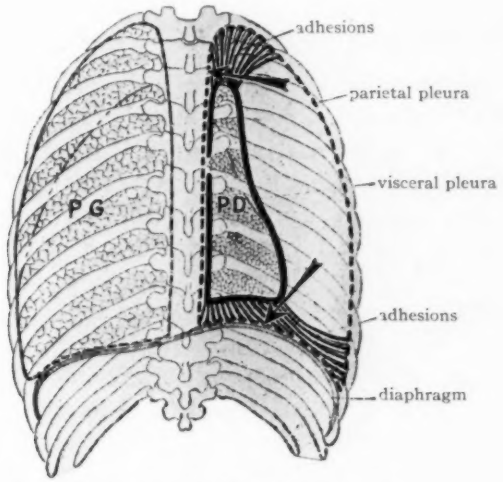

FIG. 20.—Points along which the incision should be carried at the periphery of the cavity.

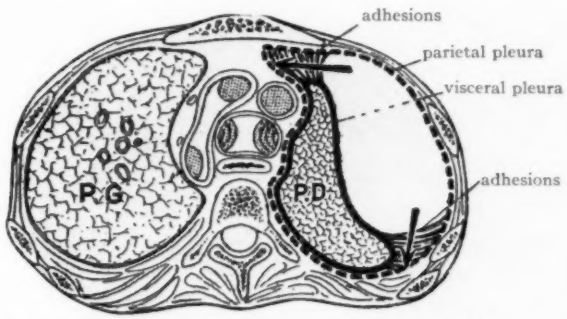

FIG. 21.—Diagram showing where the incisions should be carried in order to liberate the lung.

Complications of Operating Chronic Empyemas.—In eleven cases the wound had to be reopened because of secondary suppuration, but the accumulation was much reduced in proportion to the original cavity.

In two cases the wound had to be opened twice. All of these were cured. Two other cases had to be reopened, one for an osseous fistula, the other for hæmoptysis. Slight thoracic deformity was mentioned in nine cases and considerable deformity in a case of seven months' duration.

Content after operation	15 c.c.	Content at closure	3 c.c.
Content after operation	120 c.c.	Content at closure	45 c.c.
Content after operation	17 c.c.	Content at closure	4 c.c.
Content after operation	37 c.c.	Content at closure	4 c.c.

In three cases the pleural site was disinfected *de novo* and cured.

Subsequent medical treatment consisted in exercises for inspiration and expiration, the effect being watched by means of a registering pneumograph.

Final Results and Conclusions.—All my cases have been seen six months to three years after operation. Thoracic deformity was slight. The radiographic reading was an interesting evidence of the thickness of former adhesions or of cicatrices shown to have almost completely disappeared. The costo-diaphragmatic sinus alone was visible at its inferior portion.

To summarize, chronic pleurisies are exceptional when acute effusions are well treated. Chronicity depends on a chronic pulmonary infection or on special anatomic peculiarities. Costal resection in the treatment of chronic empyema should be reduced to the minimum. Closure of the surgical incision and pleural decortication should be preceded by disinfection of the cavity and then gives success which was formerly unknown.

(I have to thank Dr. Merrill A. M. Cross, Paris, for the translation of this article.—THE AUTHOR.)

THE TREATMENT OF CHRONIC EMPYEMA

STATISTICAL TABLE *

RECORD OF 91 CASES FROM THE MONTH OF AUGUST, 1914, TO THE MONTH OF DECEMBER, 1919

46 cases of medical purulent pleurisy.
43 cases due to wounds of the lungs.
2 cases due to infection of a hæmothorax.

I

A. Out of the 46 medical cases 29 were opened by myself and treated by the Depage-Tuffier method.

The microscopic examinations showed:

15 cases streptococci only.
5 cases pneumococci only.
7 cases association of staphylococci-diplococci and streptococci.
1 case streptococci and pneumococci.
1 case streptococci and leukocytes.

I practiced the operation at the first sign of:

Pleurisy in 9 cases from 8–22 days.
Pleurisy in 13 cases from 2½ months.
Pleurisy in 4 cases from 2⅛ months.
Pleurisy in 1 case from 4 months.
Pleurisy in 2 cases from 6 months.

The duration of the sterilization was:

7 cases from 6 to 24 days.
3 cases from 1 month.
9 cases from 1½ to 2½ months.
4 cases from 3 to 4 months (case dating from several months).
In certain cases the record was incomplete.

The volume of the cavity was about:

80 c.c. in 1 case.
200 c.c. in 2 cases.
300 c.c. in 2 cases.
700 c.c. in 1 case.
1100 c.c. in 2 cases.
1600 c.c. in 1 case.
1 litre in 1 case.
1 litre in 2 cases.
Total in 4 cases.

In another case the cavity contained about 3 litres at the opening and more than 1½ litres at the closure of the pleura.

Six patients died almost immediately after the operation, 3 were streptococci and 3 were without record of any kind.

One case was opened and treated solely by oxygen, the microscopic examination showed streptococci and dated from 3 months.

Three were opened; they recovered, but they were treated by simple drainage.

Three were opened and closed immediately. Two pneumococci (success), 1 diplococcus (failure).

* Translated by Miss Carrie Patterson.

B. Two cases were sent to me already opened and had been already treated by Dakin; they had been opened for over a month and showed streptococci; 1 dated from 4 months and had been sterilized in 10 days, the other dated from 3 years ½ and had been sterilized in 4 months. Both recovered.

C. Two cases were decorticated, 1 showing streptococci and the other was without record. One dated from 3 months, the other from 1 month. The sterilization was complete in 11 days. Result—recovery.

II

Consecutive purulent pleurisy from wounds of the lung—43 cases.

Out of these 43 cases 19 were opened by myself and treated by the Depage-Tuffier method.

The microscopic examination on the 19 cases showed 14 times association of staphylo-diplo-cocci, strepto once and distryptococci in 4 cases were not mentioned.

In 4 cases when I operated, the wound dated from 20 days.

In 2 cases it dated from 1 month and a few days.
In 5 cases it dated from 2 months and a few days.
In 2 cases it dated from 3 months.
In 2 cases it dated from 4 months.
In 2 cases it dated from 5 to 7 months.
In 2 cases there were no records.

The duration of the sterilization was:

In 5 cases 15 days.
In 8 cases 1 month and a few days.
In 2 cases 2 and 3 months.
In 2 cases 4 months.
In 2 cases without record.

In 1 case the closure took place the day of the operation. There was no sterilization. This dated from 5½ months.

B. Seventeen cases were sent to me *chronic*, 14 from 1 month. (Eleven closed Depage-Tuffier method and 3 decortications.)

The microscopic examinations showed: Ten times associations staphylo-diplo-cocci, batonnets-strepto. Once pneumococci and bacillus of Friedlander. Three cases are not mentioned.

When I practiced the operation the wound dated:

2 cases 2 months and a few days.
3 cases 3 months.
3 cases 4 months.
3 cases 5 months.
3 cases 7 months.
1 case 8 months.

The duration of the sterilization was in:

2 cases 15 days.
4 cases 1 month and a few days.
3 cases 2 months and a few days.
1 case 3 months and a few days.
1 case 6 months and a few days.

In 3 cases the pleural site was reopened, disinfected anew and the result was recovery.

Three in less than a month. The microscopic examinations showed:

1 pneumococci et bacillus of Friedlander.
1 associations of perfringens, anaërobes, staphylococci, vibrion septique.
1 without record.

All these cases except 2 actually recovered. The 2 failures were 2 bronchial fistulæ with ectasia of the bronchiæ.

THE TREATMENT OF CHRONIC EMPYEMA*

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Definition.—The word empyema is from the Greek signifying a collection of pus in a cavity. This was the sense in which the word was used by Hippocrates, Galen, Ætius, and others. Ætius, in fact, defined the term much as it would be defined to-day: he stated that those persons are called "empyici" in whom an abscess in any part of the pleura has ruptured into the pleural cavity. Aretæus *Cappadox* wrote: "Those persons in whose cavities above, along the region of the chest, or in those below the diaphragm, abscesses of matter form, if they bring it up they are said to be affected with empyema, but if the matter pass downwards they are said to labor under Apostemes." Later, Cælius *Aurelianus* and others called a collection of fluid anywhere in the body empyema. Guy de Chauliac, 1363, defined the word as follows: "Empyma or empyema in Greek signifies a collection of pus in whatsoever part of the body it may be, but more properly used meaning a collection of suppurative matter in the testes, thorax, or abdomen. In a more restricted sense it means pus in the thorax: this is the most proper and common significance. Following it one calls those who have pus in the thorax 'empyes' or 'empyiques' in Greek, and suppurants or purulents in Latin."

Later a difference of opinion developed as to whether the term empyema should be limited to collections of pus or what other effusions should also be included. Boerhaave wrote: "Whenever there is a collection of pus between the lungs and the pleura in the cavity of the chest it is called an empyema." De Sauvages, Cullen, and others, restricted the term to pus only. Kisnerus also wrote that when the fluid is not pus but serous (aquosa simplex) it should be called hydrops of the chest. It was argued by others, on the contrary, that what was blood in the thorax may have changed to pus and that therefore collections of fluid of any kind and collections of air should be included.

The drainage operation was also called "empyema" (Dictionnaire des Sciences médicales). The expression "the operation of empyema was performed" was of frequent occurrence.

Leonus *Lunensis* (Dominicus), 1597, used "empyemate" and "purulentia" as synonymous for fluid occupying sometimes all, sometimes part, of the empty cavity of the thorax (cavitate vacua pectoris).

In the modern use of the term the word may still be defined as a col-

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lection of pus in the pleural cavity, although an interlobar empyema might be construed to fall outside this definition. In the transitional stage between acute empyema and a preceding serous effusion the distinction is a matter of definition. In the chronic condition the effusion is always frankly purulent.

It is also difficult to make an inclusive definition of what constitutes chronicity. Certain types of empyema, those with large bronchial fistulas, those with cavities at the apex, and some of uncertain duration at the time they were first recognized are often potentially chronic from the onset, in the sense that they do not progress to a cure by simple drainage treatment. Perhaps the most generally accepted criterion of chronicity, however, is the duration of the process. A great many writers consider an empyema of six weeks' duration to be chronic. For the purpose of this discussion, with the exceptions noted, three months are taken as the time limit between the acute and chronic condition.

HISTORICAL REVIEW

The history of empyema up to the last three decades is essentially that of chronic empyema. To what ancient period its recognition and drainage treatment date we do not know. It seems probable that incision for drainage of empyema necessitas was done by the Chinese and Egyptians. The earliest known direct references to the condition, now extant, are those of Hippocrates. His teachings as to etiology, symptomatology, prognosis, and treatment contain much that is fundamental to our present-day conception. The symptoms and signs, as he stated them, were pain in the chest, high fever, cough, distress when attempting to lie on the sound side, and œdema of the feet and of the eyes. After an illness of fifteen days the patient was examined for fluid. This examination consisted of shaking him by the shoulders and diagnosing the presence and site of fluid by the splash. If no splash could be elicited the side in which the pain and swelling was most marked was considered the one affected. Hippocrates taught that the matter should be let out either by knife or cautery. If there was a swelling externally, he directed that an opening should be made in it, if not, the opening should be made at the level of the third rib from the last, and rather behind than in front. He made the incision superficially with a large bistoury, then continued with a lancet wrapped in linen, the point only being free, or used a trocar or trephine or the cautery throughout. After some of the pus had been let out he closed the opening with a tent of lint attached to a thread. Every day it was removed and pus evacuated. On the tenth day he injected warm wine and oil. When the discharge became clear and glairy, he introduced into the opening a hollow metal tube.

He observed that patients who became affected with empyema after pleurisy recovered if they got clear of it in forty days after the time it ruptured; but if not, it passed into phthisis. As to prognosis he stated

that if pure and white pus flowed when empyema was treated either by cautery or incision, the patient recovered; but if the pus was mixed with blood and was stringy and fetid, he died.

Euryphon, a contemporary of Hippocrates, treated empyema with the actual cautery. Celsus, who practised at the beginning of the Christian era, is the author of our next most ancient reference. He wrote on the symptomatology and prognosis much as did Hippocrates. He stated: "'Tis common for fistulæ to extend beneath the ribs. When this case occurs, the ribs in that part must be cut through on both sides and taken out lest anything corrupt be left within," and, "Fistulæ of the chest are very difficult of treatment, so that sometimes physician, sometimes patient, giving up hope, leaves the case to Nature herself."

Pliny related the story of a soldier with empyema whose life was despaired of by his physician. Seeking relief by death in battle, he was wounded in the thorax; the pus escaped and he recovered.

Leonidas *Alexandrinus,* a Roman physician of the second century, recommended the actual cautery for effecting drainage. He remarked that his contemporaries feared less to open the chest by the cautery than by the knife.

Aretæus *Cappadox,* of uncertain date, probably a contemporary of Galen, said concerning the pathology of empyema: "It is a wonder how from a thin, slender membrane having no depth, like that which lines the chest, so much pus should flow; for in many cases there is a great collection. The cause is an inflammation from redundancy of blood, by which the membrane is thickened; but from much blood much pus is formed immediately. But if it be determined inwards, the ribs being the bones in that region * * * I have said above that another species of phthisis would naturally occur. But if it points outward the bones are separated, for the top of the abscess is raised in one of the intercostal spaces, when the ribs are pushed to this side or that."

Cælius *Aurelianus,* who lived in the early part of the fifth century, according to Haller a contemporary of Leonidas, wrote on abscess and empyema. Buck credits him with being familiar with ascultation of the chest.

Galen in his writings emphasized the importance of providing for the escape of pus in the thorax in order to avoid the ravages, especially of phthisis, of which it might be the cause. He removed portions of carious ribs, injected warm wine into the cavity (pectore), and urged the patient to cough while leaning toward the affected side. If the pus and injected fluid did not thus escape, aspiration was done.

Two Greek physicians of the early middle ages who wrote on empyema are Ætius and Paulus Ægineta. Ætius, besides giving a very clear definition of the pathologic condition, stated that in certain cases empyema is formed without fever. He approved of the cautery in its treatment. Paulus Ægineta wrote a compend of medicine which later was translated

into Arabic and Latin. His writings on empyema were based on the teachings of Hippocrates and Galen but showed some originality. He is quoted by Marcellus Donatus to the effect that cautery or incision of the thorax, by allowing vitality to flow out with pus, causes immediate death or an incurable fisula results.

During the latter part of the middle ages some of the earlier medical literature was preserved by the Arabs. Their most notable contributor to surgical literature was Albucasis. He recommended incision or cautery operation for drainage of empyema. Avicenna and Avenzoar also approved of paracentesis and the cautery. Zacchias, however, said that the Arabian physicians feared the operation for empyema. Lelorraine said that the Arabs disagreed as to the advisability of operation. Nicolaus Massa, while granting that incurable fistulæ might be left after operation, maintained that a fistula is vastly better than certain death. He recorded a case of draining sinus following a stab wound that closed after seven years. He cited the case of a girl who for six days coughed up eight pounds of pus daily, and ultimately recovered.

Guy de Chauliac, besides giving a definition of empyema which very closely agrees with our present conception of the disease, mentioned that the operation was performed by his contemporaries.

Smetius, 1574, reported a case of empyema following a dagger wound of the thorax. An incision was made between the tenth and eleventh ribs and much foul pus was evacuated. The cavity was then irrigated with honey and water.

Vesalius taught that incision should always be made for empyema and that no one should die of the disease. Certain persons would die because of their wounds and not because of the operation. He referred to several cases in which he operated successfully. He wrote also on thoracic fistulæ.

Amatus *Lusitanus* was one of the first of a considerable number of physicians of the Renaissance period who wrote on empyema. His is also one of the most original and independent expositions on the subject. He outlined in detail the teachings of Hippocrates on the treatment of empyema and discussed the relative advantages of the incision and the cautery. With regard to the site for drainage, he pointed out that Hippocrates ordered that the drainage should be made as near as possible to the septum transversum (diaphragm) without injuring it. As to which interspace this should be, he said that rather than rely on the authority of Hippocrates, he determined it for himself on the cadaver. He wrote:

"At one time a brother of Andreas Vesalius, the renowned anatomist, in my presence was carefully cutting up a human body. Snatching the knife with which the excellent youth was dissecting, I made an opening between the second and third ribs on the left side, and after the knife itself had been thrust in I discovered that the 'septum transversum' could draw no harm from it. However, the mad-

ness of physicians reaches this point that they do not cut between the second and third ribs (counting from below), but rather between the fourth and fifth, or if it pleases the gods, between the fifth and sixth, although they cannot draw the corrupt matter easily without loss of the patient, since the pus is held in a bag and they cannot do away with it even when the legs are raised and the head is hanging down."

He cited a successful case in which he drained between the third and fourth ribs.

Marcellus Donatus had a case of empyema necessitas that progressed to a spontaneous cure; he remarked that almost all empyema patients and many suffering from a wound penetrating into the chest died because physicians feared to cut in the right region, an operation which he advised. However, if pus would not drain through the mouth, he believed that the opening should be made between the third and fourth ribs (counting from below) rather than lower down, on account of the danger of injury to the diaphragm. He added that the incision should be made wherever pus had collected, and cited many authorities for the statement that pus might drain through the urine. He spoke also of perforation of the diaphragm by the abscess.

Leonus *Lunensis* (Dominicus) gave detailed directions for the medical treatment, internal and external, and referred briefly to the use of incision and cautery in cases not cured by such treatment.

Castellus, in his treatise on the diseases of the thorax, discussed at great length the external and surgical treatment, but did not add anything original.

Fabricius *ab Aquapendente* systematically discussed the subject and described the instruments used by Hippocrates and by Paulus Ægineta. He stated that most persons who had received a penetrating wound in the thorax had to wear a silver tube for life and that he knew of patients who had carried tubes for twenty or thirty years. Fistulæ persist, he wrote, because of the constant motion of the chest, because the pleura is sinewy and bloodless, and because of the tortuous course of the fistulous tract. To avoid the motion, patients should be in bed and refrain from work and all speech, from wrath, and any repressed breathing whatsoever; second, the hard skin of the fistula should be removed either by softening or corroding or burning or by drug or by instrument. The pleural cavity could also be closed by the scar. Furthermore, all corruption must be removed and the fistulous tract straightened by cutting the curves with a knife. Fabricius thought that the rib resection operations recommended by Celsus were very difficult, dangerous, and cruel. He was of the opinion that a rib could not be removed without tearing the pleura and so causing the death of the patient. He recommended a curved silver drainage tube and treatment of the fistula as though it were a spring and not an ulcer.

Zacutus *Lusitanus* published records of three cases. In the first, pus drained by the urine; in the second, in which there was much purulent

sputum, the patient recovered spontaneously on a milk diet; in the third, after great fear and misgiving as to the result should operation be undertaken, it was decided to be guided by the dictum of the "old man" (oraculum senis). An incision was made and the patient recovered.

Cases were reported by Horstius, by Tulp, and by Jalon, in which pus is said to have drained by the urine, and in Tulp's case, also by the umbilicus. Cures following operations were described by Kisnerus and Riedlinus. Operative treatment was discussed by Zacchias, Camerarius, Scultetus, Fienus, and Fliccius. Scultetus' article is the earliest accessible reference in the French. He discusses indications, time, site, technic, and instruments to be used in the operation of paracentesis. He stated that the "temperament" of the air must be considered and cited Hippocrates' recommendation that the winter and summer should be avoided if possible on account of the sudden changes in the air at these seasons. He also mentioned that a purulent effusion is in need of earlier drainage than a hydrops on account of the rapid increase in amount and the ulceration produced by the latter. He believed that of all sites for drainage the seventh interspace, recommended by Hippocrates, is the best because it furnishes the most dependent drainage. He recommended injections of wine and oil after operation.

Fienus wrote on paracentesis for empyema. This is the earliest available article in the German. He defined paracentesis as a cut through which an opening is made into the body cavity (Hole des Leibes) whether by a cold iron or cautery. He discussed in a most interesting manner the problems involved in pneumothorax produced by this operation.

Fliccius, after citing the authorities with regard to suitable location for drainage, decided that the best place is between the fifth and sixth ribs. Kisnerus wrote that venesection, generally a most excellent remedy, is almost supreme in cases of empyema.

Kinner refers to blistering (ustiones) and cites Ætius, who directed that empyema patients should be burned about the neck, back, and sides in eight places in all. Kinner stated that this treatment should be shuddered at and that it was easy to believe Ætius was made a physician from a hangman or a tormentor rather than from a goldsmith.

Wilhelm ten Rhyne is quoted by Riedlinus as stating that Japanese surgeons inserted the leaves of India fig trees in empyema patients.

The available literature from the eighteenth century is essentially a repetition of the foregoing; that is, citation and discussion of authorities and a few isolated case reports. Ingram is the author of the earliest available treatise in the English. He reported a case successfully drained and took issue with Sharp, who in his "Operations of Surgery," Chapter XXIV, says that the operation "should be discarded as unnecessary when blood or matter is fluctuating in the thorax," and confines the necessity of it to "cases of water." A few other successfully operated cases were recorded by Springsfeld, Valentin, Gädücke, Carboué, and

others. Koelpin reported a case of pulsating empyema proved at operation. A few spontaneous cures and many post-mortem findings are recorded by Warner, Fürst, and Morin.

Lapeyre said that while the operation for empyema is known to all persons of the art, it is rarely practised because of the uncertainty of diagnosis and lack of assurance as to success of the operation. He believed, however, that the operation should be done oftener. He reported one case of empyema pointing in the chest wall which was opened and drained.

The greatest impetus to advance in surgery of the thorax since Hippocrates was the marked improvement in diagnosis by the art of percussion of the thorax described by Auenbrugger in 1761. It was only after several decades, however, that this new method was appreciated. The great clinician, van Swieten, who was Auenbrugger's teacher, ignored it. Stoll was the first to mention its great value in detecting pleurisy and especially empyema, in order that operation might be performed. Corvisart and Laennec[106] were among the first outside of Vienna to emphasize its importance. Corvisart translated Auenbrugger's treatise into the French.

The literature of the first eight decades of the nineteenth century is full of discordant notes with regard to the treatment and citations of patients with empyema necessitas. In some cases the cavities ruptured spontaneously; others were opened by simple incision. A great number of necropsy protocols were published.

Hourelle, 1808, wrote that in the advanced stages of empyema, internal medication is at best useless and that blistering, scarification, and fomentations are not much better. He stated that the danger is not in operation, but in the difficulty of applying it with certainty.

Burin d'Aissard stated that the operation had been feared because of the misapprehension that air in the chest will almost always kill the patient. He was of the opinion that when a fistula results it should be left to time and a good regimen.

The pessimistic note is again sounded in 1825 by Dumont, who said that there is always a possibility of cure by spontaneous absorption, by thickening of the pleura, by sclerosis, by absorption by way of the urine and bowels, or by absorption into the blood. He recommended mercury, purgatives, bleeding, and a rigid diet. He added that the most common termination is death.

Rullier, in speaking of the difficulties of diagnosis, points out that Dionis, Baffos, and Corvisart all opened the chest without finding pus and that several of their patients died.

Putegnat laid down as indication for operation acute and chronic dyspnœa, local and general œdema, and emaciation, for the relief of which all medical remedies had failed.

Colson, writing on empyema following a perforated wound of the thorax, mentioned the professional "sucer" present at every duel ready to draw out the blood from the wound. So successful was this treatment that it was thought to be of the devil; and in one case a priest refused the last sacrament to a wounded man thus treated. Bache states that the cause of chronic empyema is the failure of lung expansion.

In 1834 Faure reported before the Academy of Medicine in Paris a series of eight cases in which operation had been performed. Two patients were cured and all the others improved. This report precipitated a prolonged discussion, for many physicians held operation in disfavor. Thus Barlow stated that Andral and Louis regarded empyema as necessarily fatal. Laennec is quoted as saying that the operation for empyema is rarely successful. Of fifty patients treated by Dupuytren, only four were cured. When he himself developed empyema he refused operation and is quoted as having said that he would die at the hand of God rather than with the help of the surgeon.

The unsatisfactory status of the treatment of purulent pleural effusions is strikingly reflected in results obtained. The greater number of case reports up to 1834 were those of empyema necessitas; some patients recovered spontaneously after draining (Malin and Salomon, Shortridge, Steinheim), others after incision (Heyser, Claessens, Cleland, and Tourtuel). A few cases were recognized and treated before the chest wall was perforated (Colegrove, Martini, Wolfly). A large number of operated cases ended fatally (Kilgour, Cayol, Bonnet, and many others). Small series of cases were reported by Chambers, Oke, Hartshorne, Niese, and in 1841 a series of forty-three collected cases by Sédillot.

Colson, 1876, stated that the use of syringes, cannulas, and other aspirating devices employed by Dionis, Anel, Scultetus, Bruer, and others, had fallen into disfavor. After the work of Bowditch, in 1852, the aspiration method again came into vogue.

Gimbert reported a case in which seventy-four aspirations and lavages were done, followed by a cure. Bouchut, in 1872, told of one patient tapped fifty-eight times during sixteen months and another one hundred and twenty-two times during eleven months. In one instance 50 gallons of "matter" is said to have been aspirated during four and one-half years without any diminution in the daily amount. Simmonds found that in forty-eight collected cases treated by aspiration forty-two were unimproved.

Although the ancients, following Hippocrates' teachings, probably diagnosed and operated in many cases of empyema in the acute stage, the later operative treatment was largely for empyema pointing in the chest wall. Besides the cutting and cautery operation the use of caustic stone was also described. Some practised burning a deep hole and palpating the bottom of it for pus. In 1810 Aupepin described a "new" technic for performing thoracotomy by making the opening in the skin and intercostal tissue at slightly different levels. The valve-like arrangement so

produced was designed to prevent pneumothorax after the withdrawal of the aspiration tube.

In 1881 Homén published a series of ninety-one collected cases of patients treated by incision and published by seven different authors between 1868 and 1876. Of this group, 47.25 per cent. of patients were cured, 23.08 per cent. had residual fistulas, and 29.67 per cent. died. Fifty per cent of 52 of these patients who had irrigation in addition to incision were cured, 17.31 per cent. developed fistulas, and 32.69 per cent. died. In a larger series of 141 patients the mortality was 33.33 per cent.

Rib Resection for Drainage.—Rib resection in empyema is mentioned by Galen, who states that he removed pieces of rib that were necrosed in a case of empyema necessitas. By other physicians they were cauterized, removed, or let alone. No mention is found of resection of a sound rib until 1860, when Walter resected the eighth rib for drainage of a chronic empyema caused by a knife stab between the ribs. The fibrous membrane was removed with finger and spatula. "The cavity was so large as readily to admit the head of a child a year old." The cavity was washed with tincture of iodine, zinc sulphate, and decoctions such as of white oak bark. The chest wall retracted and the cavity was completely obliterated in the course of a year. Roser is said to have been the first to propose resection, but it was not until 1865 that he performed the operation. Peyrot, Billroth, Fraentzel, Koenig, Ewald, and others, were among the first to perform the operation. Weissenborn, 1876, reported a series of five cases.

Plastic Operation for Obliteration of Chronic Cavities.—According to Peitavy, Simon first recommended rib resection in order artificially to reduce the size of the cavity in chronic empyema. Peitavy published the case in which Simon made the observation that the cut ends of the resected ribs approximated. Simon taught this idea in his clinic in 1869. Heineke first published these observations in 1872, in his "Compendium der Chirurgischen Operations und Verbandlehre." Küster, in 1877, wrote that in chronic cases he resected one or two ribs in front of and behind the fistula. Létiévant reported a cure in a chronic case and emphasized the fact that not only drainage but collapse of the cavity was promoted by rib resection.

To Estlander, however, is generally accorded the credit of having directed attention to the principle of multiple rib resection for obliteration of chronic cavities. He resected a sufficient number of ribs completely to unroof the cavity. In his first communication,[63] in 1879, he reported six cases. In a later report[64] he emphasized that each case should be dealt with according to the condition found and that in cases with large cavities it might be necessary to repeat the operation a second or even a third time. Five of his eight patients were cured, two died, and one was still convalescing at the time he wrote.

Gallet collected the first 100 cases in which operation was performed

by the Estlander method. In 9 of the 18 patients who died, necropsy showed large cavities with collapsed lungs. Voswinckel reported the results in 129 collected and 6 personal cases of multiple rib resection. Fifty-six per cent. of these patients were cured; 20 per cent. had improved; 4 per cent. were not improved; and 20 per cent. had died. In one case the results were uncertain. Of 14 tuberculous patients included in this series, 8 died, 2 were cured, 3 improved, and 1 did not improve.

The plastic operation was variously modified. Resection of segments of the ribs at the borders of the cavity through parallel incisions was made by Tietze and others. Wilms strongly advocates this method, especially for tuberculous empyema. He calls it the "Pfeiler Resection." Jaboulay and Leymarie resected the sternal ends, and Boiffin[22] the vertebral ends of the ribs. Tietze resected the ribs as for a Schede operation, but instead of excising the pleura, tamponed it against the lung. He stated that it produces a concentric pull on the lung and diaphragm.

In 1890 Schede described the extensive resection that bears his name. After turning up a skin and muscle flap of larger extent than the cavity, the whole of the chest wall underneath was resected, the skin muscle flap being then allowed to fall against the collapsed lung. He stated that in case the cavity extends to the pleural dome, it is also necessary to resect the first rib. He reported 10 cases with 2 deaths, and later 389 collected cases with 87.7 per cent. cures and 12.3 per cent. mortality. Bergeat collected 134 cases in which 56.5 per cent. of the patients were cured; 4.5 per cent. were improved; 14.3 per cent. had residual fistulas; 1.5 per cent. were not improved, and 23.2 per cent. died. Sudeck, Depage, Beck, Helferich, Friedrich, Sauerbruch,[156] and others, attempted to lessen the duration and shock of this formidable operation by dividing it into stages by various modifications. Sudeck, Depage, Friedrich, and later Melchior and Goebel made use of the thickened parietal pleura to help in obliterating the cavity.

In 1892 Delorme enunciated a new principle in the treatment of chronic empyema cavities, namely, that of their obliteration by reëxpansion of the lung. Previous to this time attention had been consistently centred on the chest wall, the collapse of which was considered the only means of obliterating the cavity. This new method was foreshadowed by Cornil, Oulmont, Ehrmann, and others. In several post-mortem cases in which the empyema had been of three months' to a year's duration, Oulmont was able to double or treble the size of the collapsed lung by gentle insufflation. Laennec[107] also expressed the opinion that the reason the lung remained collapsed in these cases is because of the limiting membranes and not because of the condition of the lung. Others, on the contrary, were of the opinion that sclerosis in the lung tissue or inseparable adhesions on its surface preclude any possibility of reëxpansion of the lung. It remained for Fowler and Delorme to prove the point on the living patient. Fowler performed his first operation October 7, 1893, and

reported the case December 30th, of the same year. He considered the operation adapted to non-tuberculous cases, and concluded the article as follows: "The case suggests a method of dealing with some of the instances of old empyema with persistent sinus which resist all means usually employed for their cure."

In May, 1892, Delorme dissected off the parietal pleura more than 1 cm. thick in a patient with a small empyema cavity. The expansion of the lung that resulted suggested to him the possibility of obliterating large cavities by a similar procedure. In June of the same year (1892), before the Academy of Medicine, and in April, 1893, at the Surgical Congress, he proposed the method. January 20, 1894, Delorme first performed the operation in a case of empyema of four and one-half months' duration, and obtained complete expansion of the lung. To Delorme, therefore, belongs the credit of first having enunciated the principle and to Fowler the credit of first having performed the operation. In 1896 Delorme published the results in 18 cases; 5 patients were completely cured; 2 were improved; and 8 were not benefited. Delorme recognized no contraindication to operation except a poor general condition of the patient. He wrote that tuberculosis is not a contraindication, but that in its presence it is almost impossible to secure complete obliteration of the cavity.

Modifications of the decortication operation as first described by Delorme and Fowler have been numerous. The most important one designed to conserve the chest wall was the introduction of rib-spreading exposure. Roux found that by retracting at the anterior angle of an intercostal incision good exposure was secured. Sauerbruch[157] described an improved technic with subsequent suture around the ribs for air-tight closure. Friedrich and others have used rib retraction. Lilienthal[118] sectioned the ribs in addition to spreading them. Boiffin[23] used a posterior incision to secure access to the paravertebral space. Quénu and Soubottin sectioned the entire thickness of the chest wall anteriorly and posteriorly, but without removing the ribs. Krause, Jordan, Goullioud, and others did extensive resection, practically combining the Estlander and Delorme operations. Ringel and others combined the Schede and Delorme procedures. After decortication Lambotte proposed insufflation of the lung through a preliminary tracheotomy.

Successful case reports have been published by Bazy, Battle, Newton, Cotte, Meyer, and Kümmell. Lund reported seven cases with two deaths, neither due to shock. Mayo and Beckman reported seven cases, with one death. They expressed the opinion that the operation has not received the consideration it deserves. Dowd reported fifteen cases; fourteen of them were in children whose average age was five and one-half years. There was one operative death. Dowd wrote that in extreme cases there are many disappointments and that it is easier to secure expansion of the lung than to maintain it. Lilienthal[117] reported twenty cases with three

deaths, Whittemore fifteen cases with eleven complete cures and no mortality. In twenty-nine cases mentioned by Binnie, seventeen patients were cured; nine were not improved, and three died. Violet collected seventy-nine cases. Forty-eight and one-tenth per cent. of the patients were cured: 7.7 per cent. were improved; 31.7 per cent. were not improved, and 11.4 per cent. died. One case was not completed. Kurpjuweit reported fifty-six collected cases. Thirty five and seven-tenths per cent. of the patients were cured; 19.7 per cent. were improved; 33.9 per cent. were not improved, and 10.7 per cent. died.

In a case in which it was impossible to separate the thickened pleura from the lung, Ransohoff found that by making gridiron incisions about 0.6 cm. apart, a considerable expansion of the lung was obtained owing to wide separation of the cut edges of the pleura. This procedure has been used since quite extensively in conjunction with the various modifications of the plastic operations.

Lambotte recommended suturing the lung to the parietal pleura after decortication, if the lung failed to expand.

Kurpjuweit advised extensive rib resection to bring about expansion.

Souligoux proposed cutting the thickened membrane at its reflection to the parietal pleura, thus securing mobilization *en masse* if the lung failed to expand. The method appears to be practical, however, only if the lung also expands at least in part.

Robinson described a plastic operation for closure of chronic cavities posteriorly, making use of the muscles of the thoracic wall to help fill the cavity. Taddei obliterated a cavity by transplanting a lipoma. Beck obtained very good results by the use of skin flaps after radical excision of the roof of the cavity. He has also reported 80 per cent. of patients cured in 150 cases of chronic empyema sinuses in which bismuth paste was used.

Irrigation of Chronic Cavities.—The use of irrigation for chronic cavities dates back to Hippocrates. He directed that wine and oil should be injected on the tenth day. Galen and Rhazes, the Arabian, used water and honey. Guy de Chauliac employed various decoctions. Evacuants and detergents were used by Fabricius ab Aquapendente, Ambrose Paré, Dionis, Willis, and others.

Lamotte, according to Massiani, was the first to reject all irrigations. Opinions have differed on the subject ever since. Van Swieten, Ravaton, Maraud, and Pelletan used various fluids. Bell, Chopart, Desault, and Lassus condemned the practice as dangerous.

Velpeau advised irrigation in encapsulated cavities. Boinet and Boudant recommended chlorides and iodides, and Sedillot, a caustic solution, as the therapeutic agent. Since that time a great variety of solutions have been used, such as methyl salicylate, phenol, creolin, iodine, saline solution, hydrogen peroxide, boric acid and carbolated iodine, corrosive sublimate, and "purefied air." After the use of intrapleural antiseptics

fell decidedly into disrepute, it was renewed again by J. B. Murphy, who was a staunch advocate of the use of formalin in glycerine.

In the available literature, the first mention of the use of chloride of lime was by de Brabant in 1837. Townsend in 1845 recommended a " weak solution of chloride of lime as an antiseptic."

Since the work of Dakin and Carrel with the hypochlorite solution, intrapleural injection has come into favor again. Its use, however, has been largely limited to acute cases.

GENERAL CONSIDERATION OF PRINCIPLES OF TREATMENT

From the foregoing historical review it is found that, although empyema has been recognized and treated for twenty-six centuries, it is only sixty years since a sound rib first was resected for drainage. During the next thirty years attention was directed solely toward collapsing the thoracic wall for obliteration of the cavity. The most radical stage was reached in the complete Schede resection. Since that time the trend has been toward increasing conservatism, the first real contributions in this direction being those of Delorme and Fowler. It has also become more clearly and generally recognized that there is a considerable variability in the pathologic and clinical aspects of the disease.

The first essential to a consideration of treatment is a clear conception of the cause of chronicity and of the pathology involved. Since chronic cavities and residual sinuses are often but different stages in the same case, the two conditions are considered together. It should be recognized, however, that each may exist independently.

The most common causes of persistent fistula, apart from chronic cavities, are osteomyelitis of the rib, bronchocutaneous fistula, extreme sclerosis of the walls of the sinus, foreign bodies, and, occasionally, tuberculosis. The common causes of a persistent cavity are inadequate drainage; pneumothorax, whether from early open drainage or from a ruptured subpleural abscess resulting in more or less complete collapse of the lung not yet fixed by adhesions; too late drainage after the lung has become fixed firmly in a collapsed position; persistent bronchial fistulas; the presence of foreign bodies; reinfection; and tuberculosis. Of all these factors insufficient drainage is the most common. As a result of the prolonged suppuration a pyogenic membrane which may be 1.25 cm. or more thick is formed. This membrane tends to prevent expansion of the lung even after the primary cause is removed. Treatment should naturally be designed, so far as possible, to remove the cause. Dependent drainage and removal of necrosed rib or foreign material are simple procedures, yet they often bring about a cure after years of chronicity. If a bronchial fistula is present its closure is usually a prerequisite to healing.

The pathologic condition often can be recognized only in part. Conditions of the lung with respect to tuberculous and other sclerotic changes

are often difficult to determine. If an extensive pulmonary tuberculosis is present, or if the bacilli are demonstrated in the pleural exudate, or the typical microscopic picture is found in the sectioned pleura, the diagnosis is established. A history of a primary pleurisy with serous effusion, later becoming purulent, is also at least very suggestive. Often, however, the history and findings are indefinite and uncertain. Primary tuberculous empyema, secondarily infected by injudicious drainage or from within, may present a typical picture of the ordinary suppurative pleurisy.

Whether or not the lung is capable of expansion is difficult to decide with any certainty. Various methods to ascertain this have been described, mostly based on a decrease in the size of the cavity during forced expiration. Obviously such a determination may be more a measure of the relative rigidity of the thickened pleura than the elasticity of the lung. Reineboth's ingenious method, depending on the changes in pulmonary circulation that result in increasing the intrapulmonary pressure in a lung that is still expansible but in which changes do not occur if expansibility is lost, unfortunately has not so far proved of practical value. The mechanism by which a collapsed lung expands is of much practical importance and the subject of much difference of opinion. The presence of an intrapleural pressure less than atmospheric and the reason for this so-called "negative" pressure is an elementary fact in physiology. It is also recognized that if an opening is made into the pleural cavity, the lung collaspses from equalization-pressure on the two sides of the lung alveolus. Other factors of the first importance to the clinical application of these fundamentals until recently have received but scant attention. Among such factors are the size of the opening in the chest wall in relation to the size of the glottis, the presence of adhesions between the lung and the chest wall, the mobility of the mediastinum, and the vital capacity. The importance of the relationship between the opening in the chest wall and the glottis was recognized by Houston. He asked van Swieten if a person wounded in both sides of the thorax would die. On being answered in the affirmative Houston produced a small normal dog on which he had opened both pleuras three days before. This astonished van Swieten, who repeated the experiment and was persuaded that when air entered the two pleural cavities the wounds were fatal only if the two openings combined were larger in area than that of the glottis. Later Cruveilhier repeated these experiments. It remained for Graham and Bell, however, to point out the great importance of the relationship to the treatment of acute empyema. They showed that in acute cases, owing to the mobility of the mediastinum, the two pleural cavities react as one to changed intrathoracic pressure. Lowering or neutralizing the negative pressure on the one side changed the pressure the same on the other side. Graham showed that the absolute size of an opening in the chest wall, compared with that of the glottis, depends on the vital capacity at

the time. Thus a man with healthy lungs can withstand a much l. ·ger opening than one with pneumonia or poorly developed lungs.

These considerations are of fundamental importance in the treatment of empyema. The large number of variables involved explains, at least in large measure, the apparently divergent experiences and opinions on the subject of acute pneumothorax. In chronic empyema, because of the fixation of the mediastinum and the presence of pulmonary adhesions the two pleural cavities function independently. For this reason a wide opening on the affected side does not produce respiratory insufficiency.

The mechanism by means of which the lung reëxpands has been variously explained. Roser held that it was by the progressive growth of adhesions along the margins of the cavity, the contraction of which pulls out the lung. Weissgerber, on the other hand, held that lung expansion is due to increased intratracheal pressure during expiration, resulting in a summation expansion of the lung. The different conceptions are reflected in the variety of devices for increasing the intratracheal tension, on the one hand, and for decreasing the tension in the pleural cavity, on the other. More recent opinion is also divided. Physicians still use pleural suction. Perhaps the majority, however, are of the opinion that the lung, when free, expands essentially because of the increased tension from within the bronchi, during coughing, straining, or other effort involving closure of the glottis, and that closed drainage, valve action, a pus-soaked dressing, and the like are used chiefly in helping to hold the amount of expansion gained. There is much clinical evidence also indicating that progressive adhesions help to hold the lung out, once it is expanded.

Some surgeons believe that adhesions are always detrimental. Thus Lloyd, on the principle that the adhesions tend to prevent expansion, routinely separated them at operation. He reported cases of 225 patients treated in this manner, but with less than 50 per cent. complete cures and 20 per cent. mortality. Homans has expressed the belief that adhesions in the early stage are often the cause of chronicity, but that fixation of the lung to the diaphragm favors expansion.

In chronic empyema the greatly thickened membranes prevent the action of the mechanism which brings about expansion of the lung. If these membranes are removed, incised, or disintegrated, the same mechanism again comes into play, provided the lung has retained its elasticity.

At operation it is often observed that when the patient coughs or strains the liberated lung expands in response to the increased intratracheal pressure. In the after-treatment, as in the acute condition, the same factors favor permanent expansion. In the cases in which cavity obliteration occurs following the liberating action of Dakin's solution, it can be determined when operation is performed for a small residual cavity, that the lung is adhering progressively at the periphery of the cavity. Dunham observed at necropsy, in cases in which Dakin's solution was

used, that the walls of the cavity were covered with granulations favorable for adhesions, while in those in which there was no treatment a shaggy fibro-purulent deposit was found. In case of reinfection these adhesions tend to break down and the cavity enlarges.

Tuffier, Stevens, and others have reported series of cases in which, after sterilization, the tubes were withdrawn and the pneumothorax left to itself, but this method has resulted in many recurrences. If the treatment is successful, the lung apparently expands in proportion as the air absorbs, but in some instances cavities have persisted for months. It seems reasonable to believe that such treatment is more suitable in recent cases than when the condition has persisted for years. To what extent an increasing pulmonary circulation, incident to deep breathing exercise and other effort, aids in bringing about expansion, can not be stated, but some experimental evidence has been found to indicate that an increased circulation in the capillaries tends to expand the lung alveolus.

In cases of tuberculous empyema a large cavity may persist for years without any tendency toward lung expansion. At operation in some such cases it is found that the pleura is not appreciably thickened; the failure to expand is probably due to a fibrosis of the lung by which it has lost its expansibility. Fibrosis seems to occur also in long-standing pyogenic empyema.

Aside from considerations of etiology and pathology, the guiding principle in the choice of treatment should be conservatism. Chronic empyema is not necessarily incompatible with years of life and usefulness. In such cases it may be questioned whether radical treatment involving considerable loss of function is ever indicated. It would certainly seem difficult to justify a high mortality, particularly if a safer and more effective method is available. Shortening convalescence is often mentioned as one of the arguments for a radical procedure, but it seems that shortening convalescence does not justify an increased mortality. In the choice of a method of treatment the first consideration, therefore, should be the life of the patient, the second, the preserving of function, and the third, the shortening of the convalescence.

CLINICAL STUDY OF CASES AT THE MAYO CLINIC

In 49 of 150 cases of empyema at the Mayo Clinic prior to 1910 the Estlander operation was performed; in 9 the Schede resection, and in 1 the Delorme decortication. One death occurred following a Schede operation. The 210 patients with empyema treated between 1910 and November, 1917, had more or less extensive rib resections. A Schede operation was done in six instances, a decortication in seven, and Ransohoff's discission of the pleura in one. There were fourteen deaths; one followed a decortication.

During a little more than two years beginning November, 1917, 150 patients with chronic empyema have been treated in the clinic, with a few exceptions, by the writer. Eight of these patients had sinuses only,

some of which, however, were fairly extensive. The others had chronic cavities varying in capacity from 50 to 2500 c.c. One hundred and seventeen of the series had been operated on elsewhere. Most of the others came with large accumulations of pus, variously diagnosed. One boy presented himself for the treatment of an extreme scoliosis due to unrecognized empyema of probably eight years' duration. One had been given up as a hopeless case of malignant disease. Unresolved pneumonia and abscess of the lung were diagnosed in many of these cases. Fifteen had tuberculous empyema. Judging from the history, clinical findings, and course, thirteen others may also have been tuberculous. One case of actinomycotic empyema is not included.

It may be noted that three months are taken arbitrarily as the time limit between acute and chronic empyema. In some patients in the series, not previously operated on, the date of onset had to be approximated from the history. In many of the others, in which the duration was calculated from the date of a late operation, it was probably considerably longer than stated. The duration of the empyema by periods and the number of cases in each is indicated in Table I.

TABLE I

Duration of Empyema

	Cases
3 to 5 months	38
6 to 12 months	47
13 to 24 months	30
2 to 3 years	12
3 to 5 years	7
5 to 10 years	11
10 to 15 years	3
15 to 20 years	1
More than 20 years	1
	150

TABLE II

Age

	Patients
Less than 5 years	6
6 to 10 years	5
11 to 15 years	6
16 to 20 years	24
21 to 30 years	58
31 to 40 years	34
41 to 50 years	9
51 to 60 years	7
66 years	1
	150

Only eleven were children under ten, yet five of the unrecognized cases were in this age group. In one of these the diagnosis had been first diphtheria, then scarlet fever, and finally typhoid fever.

TABLE III

Occupation

	Cases
Farmer	54
Business man	23
Laborer	11
Housewife	9
Student	10
Carpenter	6
Machinist	5
Soldier	3
Miner	3
Railroad man	9
None	6
Not stated	2
Miscellaneous	9
	150

The occupation seemed to bear no obvious relation to incidence.

In nineteen cases there was a fairly definite family history of tuberculosis. Alcoholism in moderation was noted in thirty-seven, and in excess in three. A past history of pneumonia was given in 105, in several of which there had been more than one attack. Pleurisy had been present in association with pneumonia in sixty-four, and was primary in sixteen. A serous effusion followed pneumonia in two definitely tuberculous cases. In eight instances of primary effusion a definite diagnosis of tuberculosis could not be made, but several of these cases ran a clinical course characteristic of a tuberculous empyema secondarily infected.

TABLE IV

Chief Complaints

	Cases
Draining sinus	87
Pain in chest	22
Weakness	11
Fever	7
Cough	9
Abscess of lung	6
Œdema	4
Arthritis	4
	150

The history of onset was given as sudden in 108 cases, insidious in thirty-two, and not stated in ten. The etiologic factors stated in the history were as follows:

TABLE V

Etiologic Factors

	Cases
Pneumonia	65
Pleurisy	15
Influenza	38
Trauma	8
"Cold"	6
Not stated	7
Miscellaneous	11
	150

Pain was a definite symptom in sixty-five; it was localized in the thorax in fifty-seven, and in the joints in four, and associated with respiration in six. Marked weakness was noted in fifty-five; cough was present in seventy, absent in twenty-eight, not stated in thirty-two, and was associated with sputum in sixty. The sputum was profuse in eleven; 500 c.c. in three, and 1000 c.c. in two, these being cases of bronchial fistula. Dyspnœa and pallor were noted in thirty-six and weakness in fifty. Hæmoptysis was noted in four. Loss of weight was a fairly prominent symptom.

TABLE VI

Loss of Weight

	Cases
Less than 10 pounds	6
11 to 15 pounds	7
16 to 20 pounds	14
21 to 30 pounds	14
31 to 40 pounds	12
41 to 50 pounds	2
51 to 60 pounds	3
61 to 70 pounds	2
None	10
Amount not stated	34
No mention	46
	150

Fever was present in seventy-five cases, and associated with chills in twenty-two. There was a leucocytosis in two-thirds of the cases in which a count was recorded. The average counts were as follows:

TABLE VII

Leucocytosis

	Cases
10,000 to 12,500	28
12,500 to 15,000	17
15,000 to 20,000	20
20,000 to 25,000	14
25,000 to 30,000	5
30,000 to 40,000	2
None	45
Not stated	19
	150

A persistent high leucocyte count was frequently observed in the cases in which Dakin's solution treatment was used without fever or other symptoms of toxic absorption. A secondary anæmia was present in the majority of patients, and to a considerable degree in about a third. The averages in 126 were as follows:

TABLE VIII

Hæmoglobin

	Cases
40 to 50 per cent.	10
50 to 60 per cent.	30
60 to 70 per cent.	46
70 to 80 per cent.	36
80 to 90 per cent.	4

A low blood-pressure indicative of an asthenic condition was noted more often than a high pressure. No significant variation was found between systolic and diastolic pressures.

TABLE IX

Systolic Blood-pressure

	Cases
80 to 90	3
90 to 100	15
100 to 110	24
110 to 140	77
140 to 160	5
160 to 180	1
Not stated	25
	150

The urinalysis indicated only a relatively small number of cases with kidney involvement, even though the average duration was more than one year in sixty-five of the cases. On the basis of the terminology used in the Mayo Clinic, "albumin 1" signifies the slightest possible trace demonstrable. The albumin content was found to be as follows:

TABLE X

Albuminuria Graded 1 to 4

	Cases
Grade 1	66
Grade 2	25
Grade 3	1
Grade 4	1
None	43
Grade not stated	14
	150

Bacteriologic studies of the exudate at operation revealed the usual bacterial flora. Except for tuberculous infection, there appeared to be no clear relationship between the type of organism and the severity or course of the process in these chronic cases.

The right side was involved in eighty cases and the left side in seventy. The most constant physical signs aside from the presence of a sinus were dulness and flatness to percussion in varying proportion and degree. Dulness was noted in eighty-three and flatness in sixty-two.

Limitation of respiratory excursion was found in the majority of cases.

Fremitus was noted in the area involved in eight cases. Clubbing of the fingers was stated to be present in nineteen and clubbing of the toes in one. The heart was displaced to the right in fifteen and to the left in nine. A palpable liver and spleen, indicative of a degeneration, was noted in five and six cases, respectively.

The clinical diagnosis of the presence of empyema presented little difficulty. A typical empyema is most apt to be overlooked in children. Occasionally an encapsulated empyema with a large bronchial fistula may be quite difficult to distinguish from an abscess of the lung. In some cases, as in one of this series, both were present. In other cases in which there is a history of cough with large amounts of sputum, the differentiation may be impossible without X-ray. Three patients in this series with such symptoms had been treated for months for abscess of the lung. In one instance an empyema had persisted for years without breaking through either lung or chest wall. One case of typical empyema necessitas simulating an acute mastitis was observed. The clinical diagnosis supported by the X-ray examinations in this series was as follows:

TABLE XI

Clinical Diagnosis

	Cases
Chronic empyema	115
Effusion or empyema with tuberculosis	9
Empyema with pneumothorax	7
Empyema with bronchial fistula	8
Empyema or abscess	3
Pleural effusion	5
Pneumonia	1
Dermoid cyst	1
Echinococcus cyst	1
	150

It will be noted that a diagnosis of tuberculosis was made clinically in nine of the cases, but the tuberculous lesion was in the lung in five; a tuberculous effusion was specified in four. A diagnosis of a pulmonary lesion was made in three additional cases by the Röntgen-ray. One of these and two others were proved microscopically. All of these patients gave a history of pleurisy with effusion. Thirteen other patients gave a similar history of a primary pleurisy with effusion. Four of these patients were later proved to have a tuberculous infection of the pleura. Three who were shown by the röntgenogram to have pulmonary involvement clinically responded very well to treatment; the other two reacted in a manner characteristic of a tuberculous empyema. From these findings it appears that while both a pulmonary lesion and a history of a preceding pleurisy with effusion are important in the differential diagnosis of a tuberculous empyema, a pleurisy with effusion is probably the more significant. A tuberculous empyema may run its course without any clinical or Röntgen findings to suggest the condition (Fig. 1).

The choice of surgical treatment for chronic empyema has been between simple drainage and some type of operation designed to collapse the chest wall or to expand the lung. In the earlier cases in this series, if a cavity of any size persisted, simple drainage was first tried, followed by a decortication. In the autumn of 1918, Dakin's solution was first used in an attempt to obtain partial sterilization of the cavity before a decortication or plastic operation was performed. It was then discovered that not only the patient's general condition was improved greatly, but the cavity showed an unmistakable tendency to reduce. The solution was then used systematically and an extensive operation performed only after the hypochlorite solution treatment had been tried. If operation was indicated for a cavity of considerable size in a non-tuberculous case, an attempt was made routinely to obtain expansion of the lung before a collapse operation was performed.

Methods of Treatment.—The methods of treatment were as follows: (1) Simple rib resection, forty-two cases; (2) Dakin's solution with or without minor drainage operations, fifty-one cases; (3) pulmonary decortication, thirty cases; and (4) plastic operation on the chest wall, twenty-seven cases.

1. *Simple Rib Resection.*—Thirty-four of the forty-two patients in this group had been operated on elsewhere. Many of them had undergone several, and one eleven drainage operations. Among those who had not had previous operations there were several with large cavities. Two had bronchial fistulæ and were emptying the contents of a large cavity through the bronchus. Two had drainage tubes in the pleural cavity, the presence of which had been unsuspected. Faulty drainage was the rule; the drainage opening had been allowed to close or narrow down to a sinus before the cavity had become obliterated, or the opening was not at the most dependent point. The capacity of the cavity in this group was less than 250 c.c. in twelve, between 250 and 500 c.c. in eight, and near 1000 c.c. in two; in one the lung was almost wholly collapsed.

The results of simple drainage operation, not counting the tuberculous cases, were: Complete recovery, twenty-six cases; persistent sinus at last report, four cases; and death, one case. Eight patients could not be traced. Of the tuberculous patients one was greatly improved, one somewhat improved, and one was not benefited. All three had been drained previously elsewhere.

2. *Dakin's Solution With or Without a Minor Drainage Operation for a Small Residual Cavity.*—There were fifty-one cases in this group. The technic employed consisted in the insertion of a catheter through the old sinus or through a trocar and cannula, aspirating the pus and irrigating with the sodium hypochlorite solution. As a rule, normal saline solution was used for the first irrigation, and if there had been cough with sputum it was used always in order to avoid the marked bronchial irritation if a bronchial fistula should be present. Irrigation was performed at intervals of from one to three hours. Once or twice each day the cavity was half filled with the solution, which was aspirated after about ten minutes. Once a week the cavity was filled by gravity and the capacity noted. In this way progress was measured. The patients were encouraged to use blow bottles and other devices to produce increased intratracheal pressure. While they were blowing the catheter was connected with a tube, the other end of which was under water in order to allow the air to escape as the lung expanded and to prevent its return. The patients were given setting-up exercises and encouraged to be outdoors as much as possible besides. A generous diet was prescribed.

TABLE XII

Results of Dakin's Solution Treatment in Fifty-one Cases

Capacity of cavity	Average number of days of treatment	Capacity of cavity at end of treatment	Average decrease in capacity of cavity per cent.	Cases
Less than 100 c.c.	35.9	10 c.c.	90.0	11
100 to 250 c.c.	34.1	11 c.c. to 27.5 c.c.	89.0	16
250 to 500 c.c.	56.4	11 c.c. to 22.0 c.c.	95.6	15
500 to 1000 c.c.	45.2	11 c.c. to 22.0 c.c.	97.8	5
1000 to 2000 c.c.	32.0	80 c.c. to 160 c.c.	92.0	4

	Cases
Complete recovery	34
Sinus at last report	6
No late report	6
Convalescence not completed	4
No benefit (tuberculosis)	1
	51

A large portion of the time spent in treatment was for the final obliteration of a cavity after it had been reduced 50 to 75 per cent. (Figs. 2 and 3).

Besides the reduction in the size of cavities of more than 90 per cent., there was a striking general improvement in all these patients. A gain in weight of from 1 to 2 pounds each day for a period of two or three weeks was frequently observed. A slight amount of bleeding and occasionally some cough were noted, but no serious complications. The hypochlorite solution was used in fifteen patients preliminary to pulmonary decortication. Six were treated for a period not exceeding three weeks, all of these showing an appreciable decrease in the size of the cavity. In the other cases, with one exception, there was also a material decrease (Figs. 4 to 12).

TABLE XIII

Result of Dakin's Solution Treatment Preliminary to Decortication in Fifteen Cases

Capacity of cavity	Duration of empyema, months	Days of treatment	Capacity of cavity at end of treatment
360 c.c.	6	9	210 c.c.
500 c.c.	20	10	200 c.c.
200 c.c.	21	12	100 c.c.
500 c.c.	6	12	180 c.c.
240 c.c.	4	19	150 c.c.
300 c.c.	4	21	240 c.c.
150 c.c.	3	27	150 c.c.
420 c.c.	15	30	390 c.c.
1000 c.c.	14	32	90 c.c.
150 c.c.	7	42	15 c.c.
1500 c.c.	3	43	100 c.c.
400 c.c.	4	46	30 c.c.
500 c.c.	6	70	60 c.c.
2000 c.c.	6	75	120 c.c.
2000 c.c.	14	150	240 c.c.

Several of the patients in this series would not have withstood an operation of any magnitude without the preliminary treatment. One was a girl with complete collapse of the lung following traumatic empyema. She was reduced from 120 pounds to 73 pounds and was brought to the clinic on a stretcher. She was completely cured with almost full re-expansion of the lung. Another patient had an almost total pneumothorax, a complete inhibition Wassermann reaction, and a severe grade of nephritis with œdema. His blood was rendered negative to the Wassermann test, his lung reëxpanded about 90 per cent., and he gained about 30 pounds as a result of the preliminary treatment.

3. *Pulmonary Decortication.*—There were thirty cases in this group. The operation, except in some early cases before Dakin's solution was employed as a routine, was performed only after the antiseptic method had been used and a large cavity remained. In a few of the early cases, only, the cavity was comparatively small. In these cases in which it failed to obliterate, it had been rendered relatively sterile, and the patient's general condition was very materially improved.

Decortication was done under general anæsthesia through a rib-spreading exposure. By use of a suitable rib retractor, adequate exposure was obtained without cutting the ribs. In some cases in which the cavity lay very high, incision was made in the sixth or fifth interspace, cutting the scapula across and resuturing it. Possibly resection of the ribs posteriorly would have been a better procedure. The thickened visceral pleura was incised and separated by blunt dissection. In many cases the preliminary irrigation had softened it to such an extent that the separation could be done very readily. If cavities were large a complete visceral decortication was done, mobilizing the entire lung. In one case only, of primary tuberculous empyema, it was absolutely impossible to separate or satisfactorily to incise it, but partial obliteration of the cavity was secured by mobilizing the lung, as first suggested by Souligoux.

TABLE XIV

Results of Decortication in Thirty Cases

	Cases
Complete cure without further surgery	15
Complete cure after secondary plastic operation for small residual cavity	5
Persistent sinus, last report	3
Death following operation	1
Death from other causes several weeks after patient left hospital	3
Under treatment	3

Two of the three patients with small sinuses were tuberculous. In

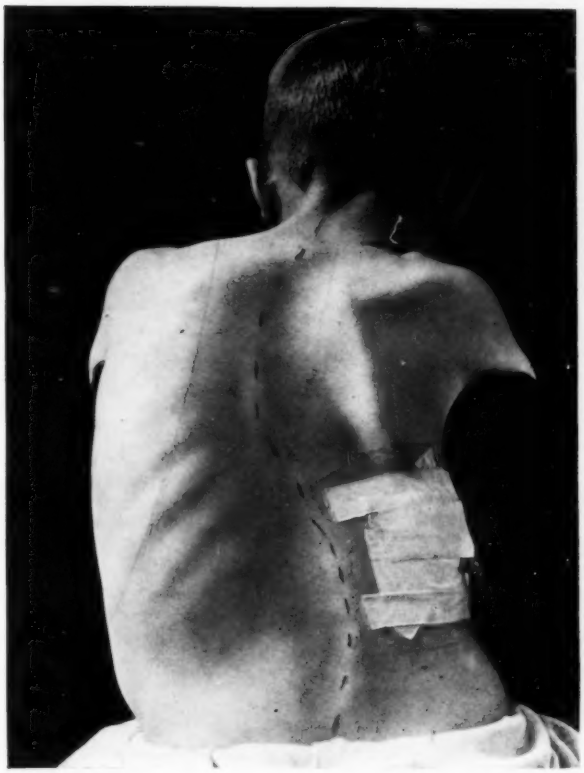

FIG. 1. (Case 269926).—Unrecognized empyema probably of eight years' duration; cavity obliterated by Dakin's solution and minor drainage operation.

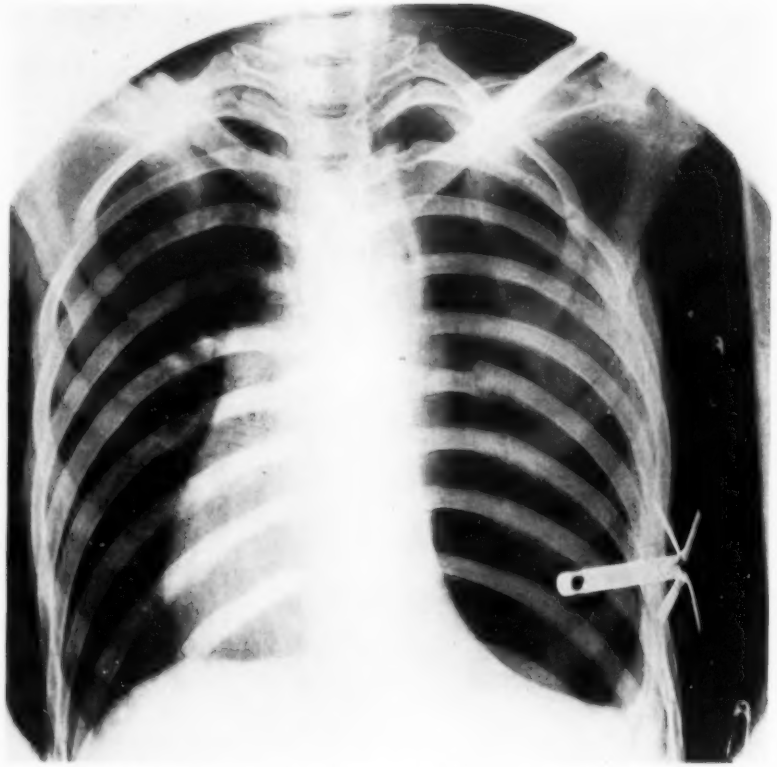

FIG. 4 (Case 261485).—Traumatic empyema of four months' standing; fracture of ribs; almost complete collapse of the lung before Dakin's solution treatment. Patient's weight, 73 pounds; normal weight, 125.

FIG. 5 (Case 261485).—Full expansion of the lung at the apex of empyema cavity shown in Figs. 4 and 5 after about four months' treatment. Complete cure followed plastic operation on residual cavity.

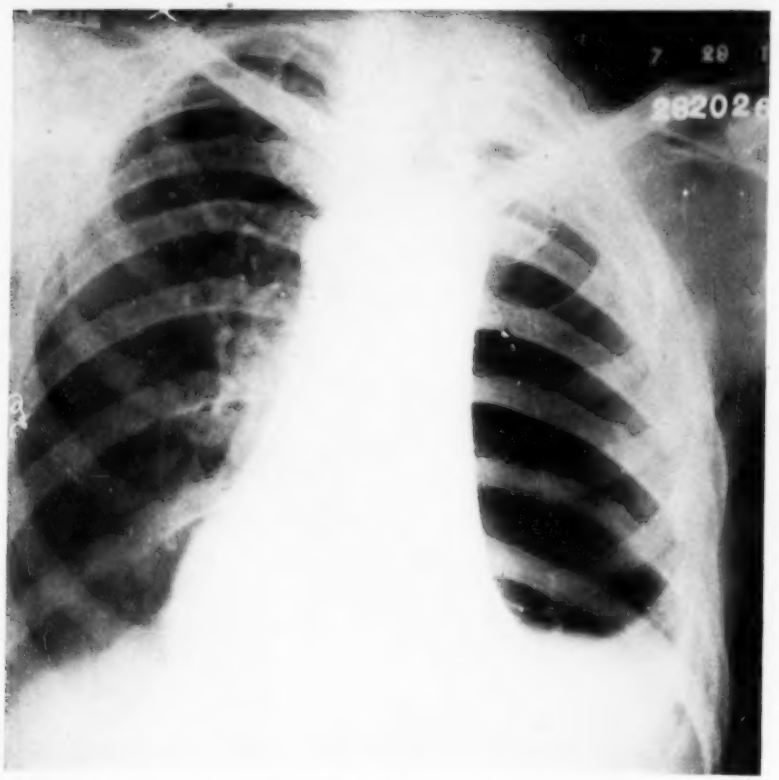

FIG. 6 (Case 282026).—Chronic empyema of eighteen months' duration; with massive collapse of lung; chronic nephritis with œdema, and complete inhibition Wassermann test.

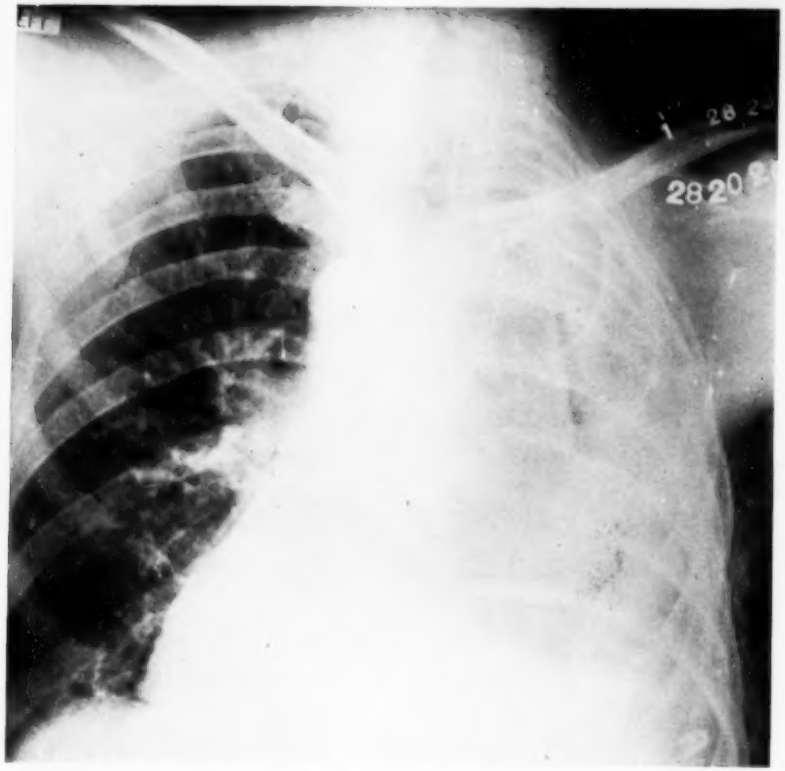

FIG. 7 (Case 282026).—Lung shown in Fig. 6 partly expanded; Wassermann negative, and patient gained 30 pounds in weight.

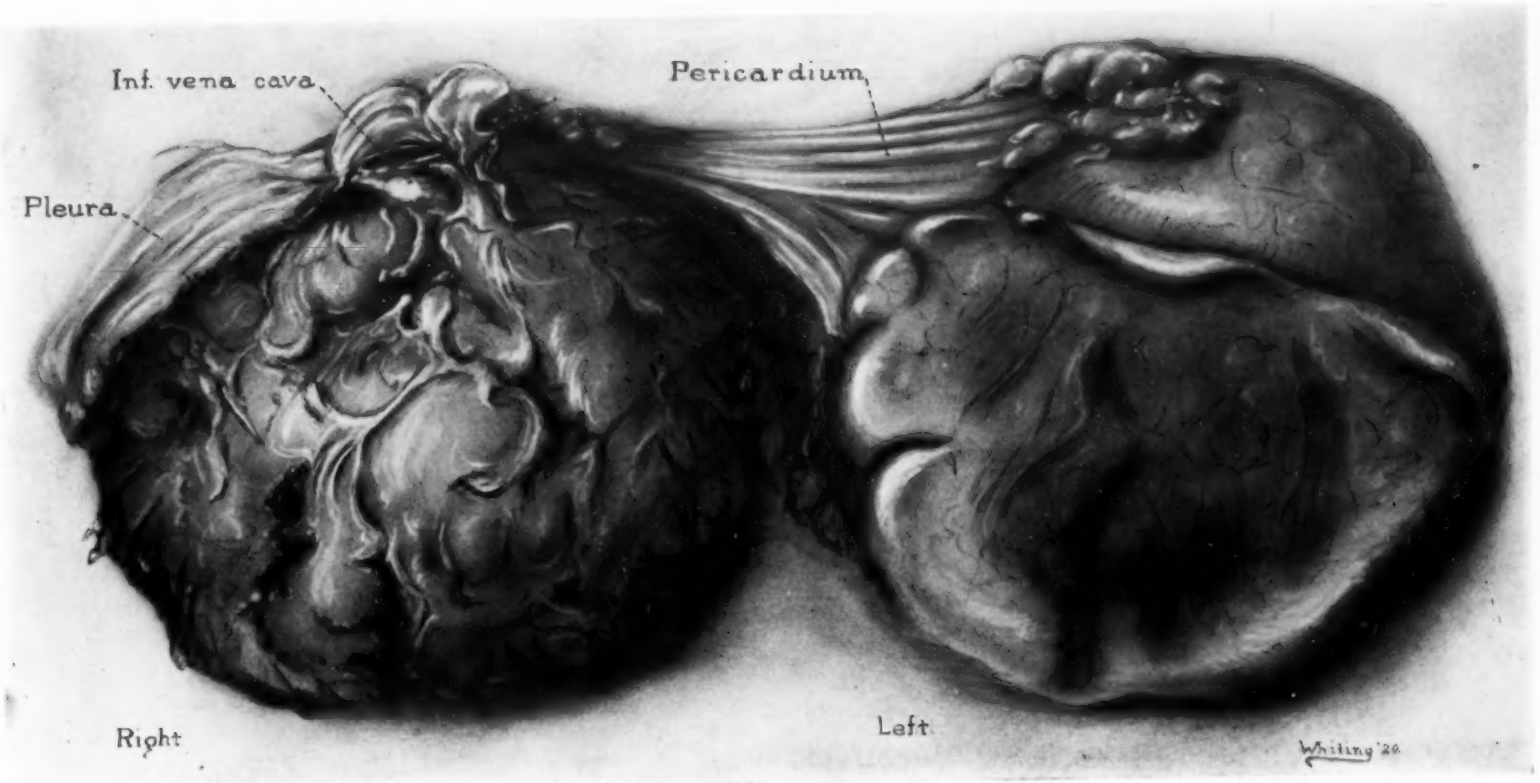

FIG. 8 (Case 307155).—Partial expansion of lung following decortication for empyema, after complete collapse of sixteen months.

one of these the cavity was practically obliterated. The patient gained very materially in weight and general condition following operation. The one operative death was due to a streptococcus pneumonia occurring during an influenza epidemic. Two of the patients who died several weeks

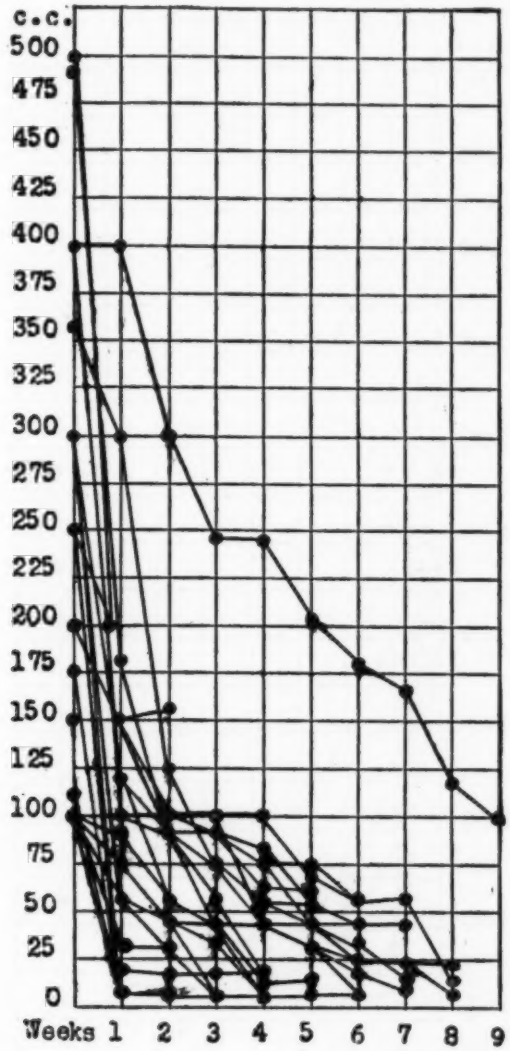

FIG. 2.—Twenty-eight cases, capacity from 100 to 500 c.c.

after operation also had epidemic influenzal bronchopneumonia. Necropsy in one of these showed one lung expanded and an empyema on the other side. The third patient, in whom the cavity had been reduced to about 30 c.c. capacity by operation, died of pulmonary hemorrhage seven months later. Tuberculosis bacilli were found in the exudate and tubercles in

the pleura shortly before death. At no time did the X-ray show any evidence of tuberculosis (Figs. 13 to 17).

4. *Plastic Operation Involving the Collapse of the Chest Wall.*—Twenty-seven patients were treated by this method. The duration of the disease

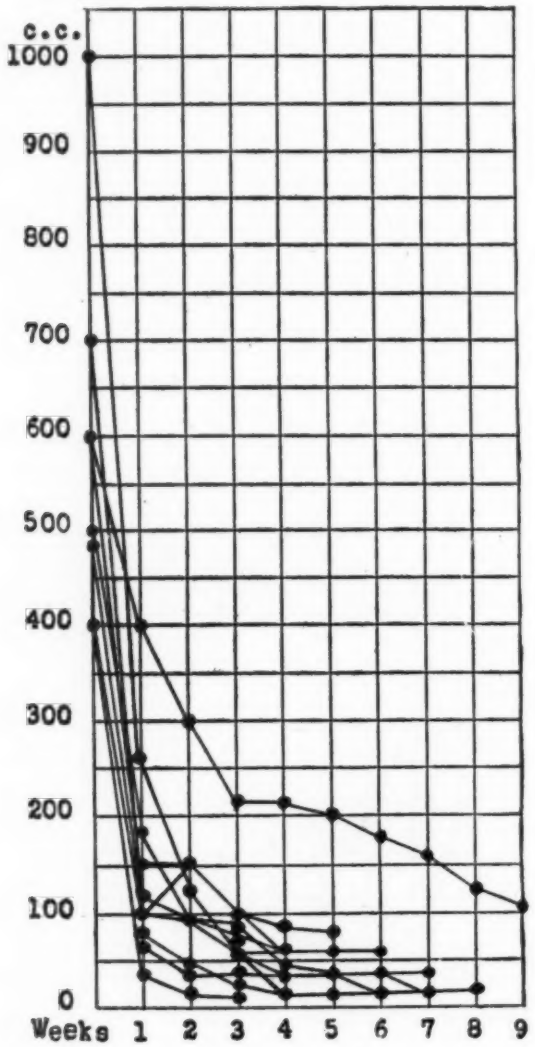

FIG. 3.—Ten cases, capacity from 400 to 1000 c.c.

was more than one year in twenty-one and more than two years in eleven; in one it was of twenty-three years' duration. Five patients were definitely proved to be tuberculous; two others belonged to the group of primary pleurisy with effusion which ran a course suggestive of tuberculosis. Dakin's solution was used in eight patients in this group (Fig. 18).

TABLE XV

Results of Dakin's Solution Treatment Preliminary to Plastic Operation in Eight Cases

Capacity of cavity	Duration of empyema	Days	Capacity of cavity at end of treatment
500 c.c.	3 months	22	120 c.c.
150 c.c.	4 months	55	30 c.c.
60 c.c.	3 years	57	45 c.c.
100 c.c.	3 years	35	100 c.c.
200 c.c.	10 months	30	60 c.c.
150 c.c.	1 year	9	150 c.c.
500 c.c.	9 months	47	30 c.c.
750 c.c.	7 years	90	300 c.c.

In nineteen cases the solution could not be used on account of fistulas, or they were early cases treated before the solution was used routinely.

The operation involved resection of the ribs over the entire cavity, and with one exception, in which an Estlander operation was performed, excising the intercostal tissue and parietal pleura. A complete Schede operation was not found necessary in any case. The extent of rib resection was reduced in the majority of cases by the skin sliding method described by Beck. In a few instances a skin-muscle flap, as recommended by Robinson, was made. Resection of the lower angle of the scapula was necessary in three instances in which the cavity lay directly under it. In one case of tuberculous empyema of twenty-three years' standing, the whole chest wall was resected *en masse,* after the method recently described by Peuckert. In another, also tuberculous, the Wilms operation was performed in three stages.

TABLE XVI

Results Following Plastic Operation in Twenty-seven Cases

	Cases
Cure	15
Residual sinus at last report	3
Death	2
Convalescence not complete	4
Not traced	3
	27

Two of the patients with persistent sinuses were tuberculous. In one the sinus closed after many months. In one the sinus was due to multiple bronchial fistulas with an associated bronchiectasis. The closure of bronchial fistulas, as I have mentioned, is necessary to the cure of an empyema cavity.

The cases of bronchial fistulæ in this series may, for convenience, be divided into three groups; namely, those in which the fistulæ closed spontaneously, those in which it was obliterated by operative procedure, and those in which it persisted.

In the first group are a number of cases in which the hypochlorite solution was used. A bronchial fistula was judged to be present if the patient coughed during irrigation and at the same time tasted the solution. In some instances these symptoms were so slight and transitory that the treatment could be continued provided the cavity was not filled. In others irrigation could be done only when the patient assumed a certain posture. Occasionally it was necessary to substitute saline solution for longer or shorter periods. In a considerable number there was slight bleeding from time to time. In no case was the bleeding profuse. In a few the fistulas were observed at operation; they were uniformly small.

In the second group are the ten cases in which the fistulas were 0.7 cm. or more in diameter. They were multiple in one case only. Four were due to perforation of large unrecognized empyemas of long standing. These closed after wide open drainage was provided. In one case of ten years' duration a large fistula was found at the costovertebral angle. It was closed by an extensive resection and cauterization of the tract. In another instance the scar tissue was completely removed and the edges of the fistula sutured after preliminary cauterization. The remaining four fistulas were closed by resection of the ribs and thickened pleura followed by skin plastic.

In the group of cases with persistent bronchial fistulas were two tuberculous cases. In one an unsuccessful partial plastic operation was done; in the other no treatment was given for the fistula. A third patient had twenty or more bronchial fistulas in the same lobe of the lung, with extensive bronchiectasis. Considerable improvement in the general condition and obliteration of most of the fistulas resulted from granulation tissue proliferation after cauterization (Fig. 19).

RESULTS OF ALL METHODS OF TREATMENT

TABLE XVII

Summary of Results of Treatment in 150 Cases of Chronic Empyema

	Drainage operation Cases	Dakin's solution treatment Cases	Decortication operation Cases	Plastic operation Cases	Total Cases
Complete recovery	26	34	20	15	95
Residual sinus at last report	6	6	6	3	21
No report, or convalescence not completed	8	10	3	7	28
No relief	1	1	0	0	2
Death *	1	0	1	2	4
Total	42	51	30	27	150

Some of the persistent sinuses followed plastic operations for tuber-

* Besides the patients whose deaths were recorded as operative, four patients died after leaving the hospital, two several weeks after operation of streptococcus pneumonia; one died seven months after operation of tuberculosis, and one of "meningitis."

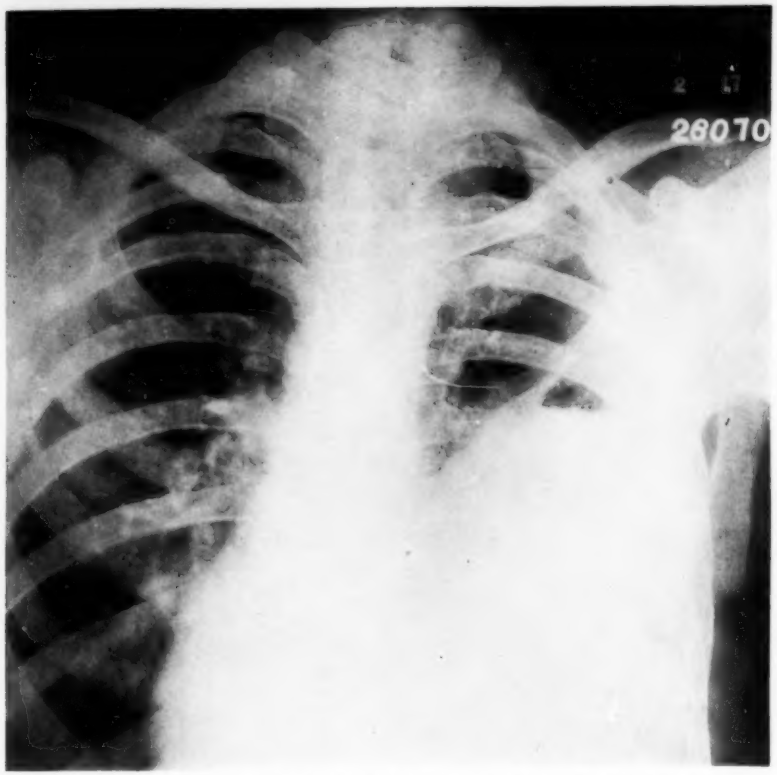

FIG. 9 (Case 260701).—Chronic empyema of four months' standing before treatment.

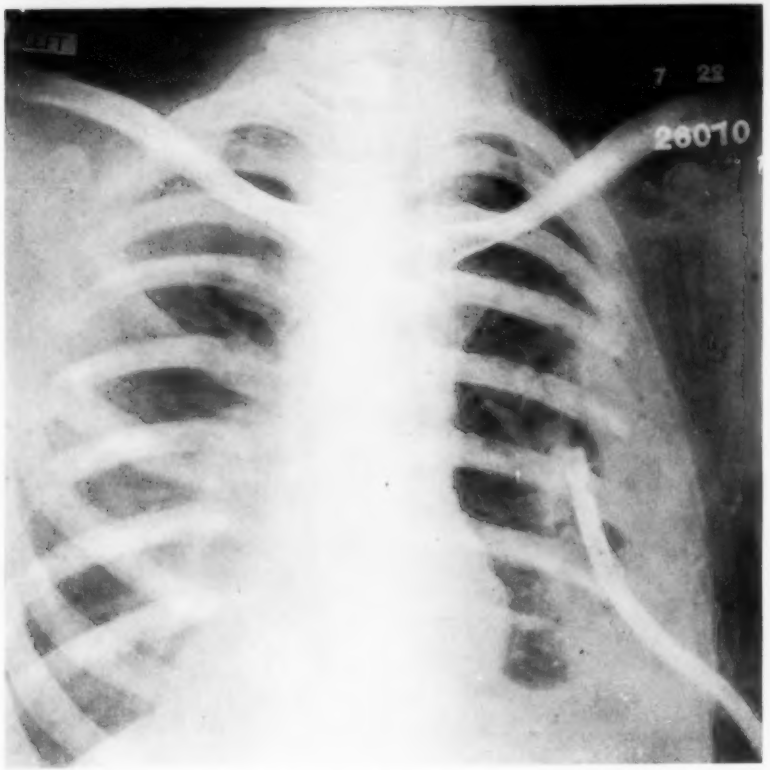

FIG. 10 (Case 260701).—Residual sinus of chronic empyema (Figs. 18 and 19) about nine weeks after decortication. Later cure was complete.

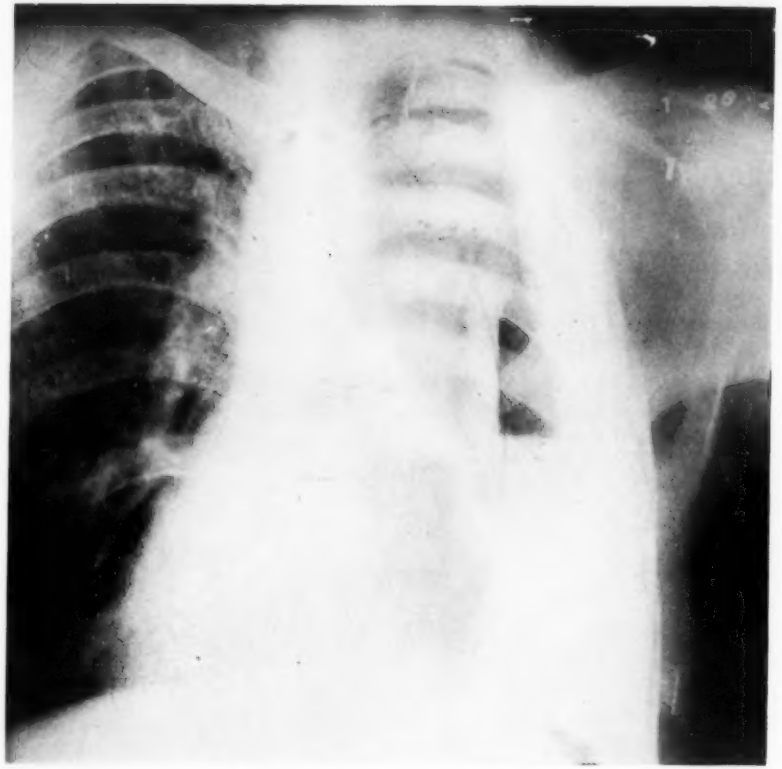

FIG. 11 (Case 185290).—Tuberculous empyema; partial obliteration of the cavity by the use of Dakin's solution treatment.

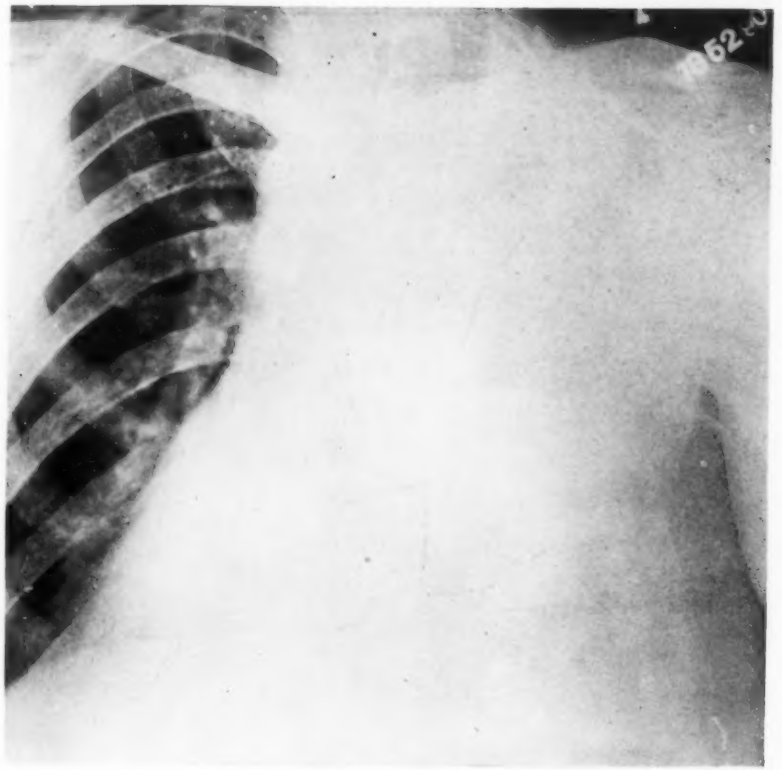

FIG. 12 (Case 185290).—Tuberculous empyema following Wilms' operation for obliteration of residual cavity.

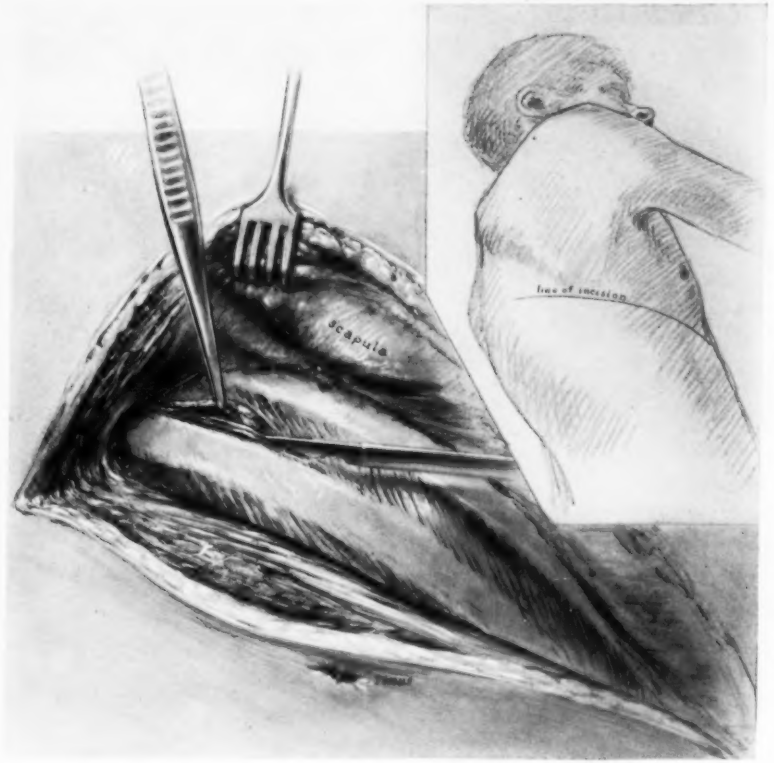

FIG. 13.—Intercostal incision for exploration of chronic empyema cavity.

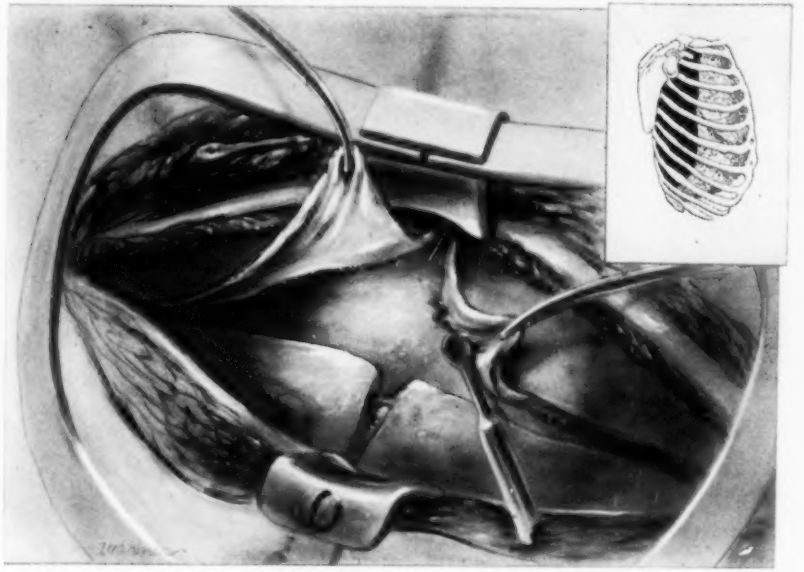

FIG. 14.—Decortication following a crucial incision in the pleura in a case of large cavity. The apex of the scapula has been removed, the ribs being divided in the sixth interspace. Retractor devised by the writer.

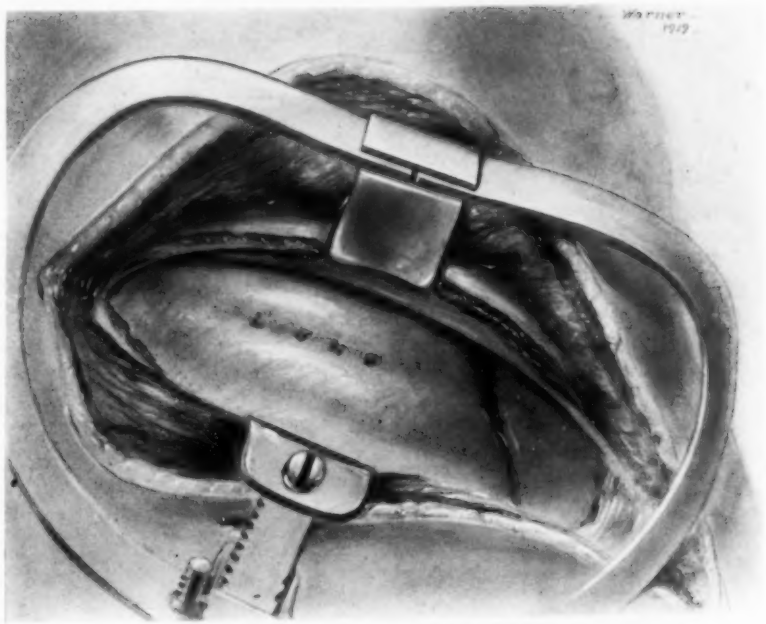

FIG. 15.—Lung expanding with straining of the patient.

FIG. 16.—Air-tight closure of chest wall. Catheter through old sinus or through stab wound for aspiration and suction.

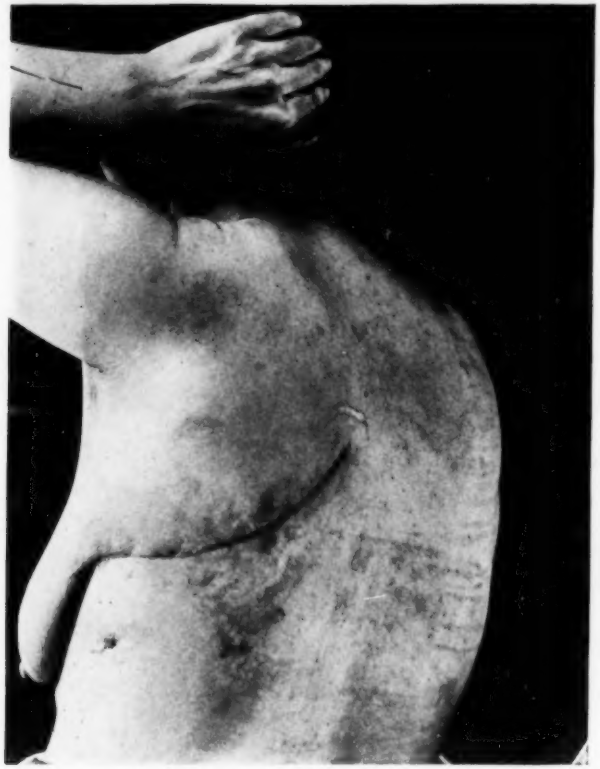

FIG. 17 (Case 251963).—Primary union following intercostal incision for pulmonary decortication. All ribs intact. The patient has free use of her arm.

FIG. 18 (Case 214734).—Plastic operation for closure of the chronic cavity.

FIG. 19.—Multiple bronchial fistulas in a patient with chronic empyema with bronchiectasis.

culous empyema, others are in recent pyogenic cases giving promise of complete closure. Practically all non-tuberculous sinuses can be obliterated by plastic operation. Since, as experience has shown, however, that the majority of the sinuses heal spontaneously, expectant treatment for a limited period has been considered justified and in many cases advisable.

TABLE XVIII

Operative Deaths

Cause of death	Operation	Cases
Sepsis and inanition	Rib resection for drainage	1
Cerebral abscess	Plastic operation	1
Tuberculous meningitis	Plastic operation	1
Influenzal pneumonia	Decortication operation	1
		4

CONCLUSIONS

From the study of the literature and of 150 cases from the Mayo Clinic, the following tentative conclusions may be drawn:

1. Chronic empyema has been recognized and treated during twenty-six centuries, but it is only sixty years since the first rib resection for drainage was done. The successive stages in the progress of treatment since that time are as follows:

(*a*) Increasingly radical treatment, designed to obliterate the cavity by the collapse of the chest wall, involving successively more extensive operations, and culminating finally in a complete radical resection.

(*b*) A conservative trend manifested primarily in the modifications of the complete resection, but more in the attempt to preserve the chest wall and to restore the lung to its structural and functional relationships as first advocated by Delorme.

(*c*) The adaptation of the Carrel-Dakin hypochlorite solution technic to the treatment of chronic empyema cavities.

2. Chronic empyema is a disease which is not incompatible with life nor with a fair degree of health and usefulness. The principles of treatment should, therefore, be, first, the preservation of life, and second, as far as possible, the conservation of function. Shortening convalescence, while very desirable, should always be a subsidiary consideration.

3. The choice of treatment must be made with cognizance of the variable etiology and pathology of the process, and the general condition of the patient.

4. A major procedure is indicated only if non-operative or less extensive surgical treatment reasonably may be considered less effective.

5. In case of sinuses and small cavities, adequate drainage is usually sufficient to effect a cure with or without short preliminary hypochlorite solution treatment. It is at least open to question whether a radical

operation is indicated in these cases for the sole purpose of shortening convalescence at the risk of an appreciably increased mortality.

6. Dakin's hypochlorite solution treatment is the method of choice in the treatment of the ordinary type of chronic empyema cavity of any size, for the following reasons:

(*a*) The general condition of the patient is, as a rule, improved to a remarkable degree.

(*b*) The cavity may be obliterated or greatly reduced in capacity by the liberation and expansion of the lung (resulting from the treatment).

(*c*) If the lung expands in part the extent of a later operation will be proportionately reduced.

(*d*) If the lung entirely fails to expand, the cavity will have become relatively sterile in preparation for operation, thereby lowering post-operative morbidity and mortality.

(*e*) Pulmonary decortication will be materially facilitated in some cases, owing to the softening action of the solution on the visceral pleura.

7. A pulmonary decortication through a rib-spreading exposure after preliminary hypochlorite solution irrigation is the most conservative treatment for cavities that are not obliterated by drainage or Dakin's solution treatment alone. If such an operation is successful, the lung is restored to its normal structural and functional relationship, thereby obliterating the cavity. If the operation is only partly successful, the magnitude of a secondary destructive operation is proportionately decreased.

8. Since it is impossible to judge with certainty before operation of the relative expansibility of the lung in every recent non-tuberculous case, a decortication should be done rather than a destructive operation, thereby giving the patient the benefit of the doubt.

9. If the lung does not expand, or if a considerable cavity persists following decortication, a plastic operation is indicated.

10. If the cavity is of considerable extent or the patient debilitated, a two- or three-stage plastic operation is to be recommended.

11. The recognition of tuberculous empyema is often difficult. A history of a primary pleurisy with effusion seems more often to signify a tuberculous condition than does a pulmonary lesion, unless the latter is active and extensive. A tuberculous empyema may be present in the absence of clinical or X-ray evidence of pulmonary involvement. The typical microscopic picture in the sectioned pleura or the demonstration of the bacilli in the exudate may constitute the only evidence in such cases.

12. A tuberculous empyema not secondarily infected should not be drained, and should be aspirated only for a considerable accumulation of fluid. For a tuberculous empyema secondarily infected, either by operation or spontaneously, drainage is necessary.

13. In the absence of bronchial fistulas and of bleeding, secondarily infected tuberculous empyema may be markedly benefited by antiseptic solution treatment. The amount of fibrosis or other pathologic change

in the lung in such cases determines the degree of expansion of the lung, whether following antiseptic solution treatment or decortication.

14. If the lung fails to expand in whole or in large part, a several-stage operation designed to collapse the chest wall is indicated. Tuberculous patients are relatively poor operative risks.

15. Adequate drainage is the first indication in cases of empyema cavities which are draining through large bronchial fistulas. The fistulas may be obliterated spontaneously following such treatment.

16. Operative closure of bronchial fistulas that persist is necessary to complete healing. It may be accomplished by decortication of the involved portion of the lung with cautery, suture, or skin plastic to cover the opening of the fistula. Occasionally healing results from simple granulation of surrounding tissue after destruction of the epithelial lining of the bronchial stoma.

17. Closing the bronchus that is draining pus from within the lung may result in a secondary lung abscess.

18. A large bronchial fistula is a contraindication to Dakin's solution treatment.

19. Sinuses of variable duration are common following more or less complete obliteration of empyema cavities; a large proportion eventually are obliterated without radical treatment; for those which persist, plastic operation is indicated.

20. Operative mortality in chronic empyema has been due largely to shock and infection. Reduction of the extent of operation and preliminary sterilization will materially lower this mortality.

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THE MORELLI METHOD OF ASPIRATION DRAINAGE FOR ACUTE EMPYEMA *

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For many years surgeons operating for acute empyema have striven to obtain air-tight suction drainage of the chest, recognizing its importance and value in securing early re-expansion of the lung, and hence in bringing about prompt functional cure.

It is quite generally recognized that a very important factor is the institution of suction drainage at a time when expansion of the lung is still possible; that is, before the retracted lung has become bound down by tough, organized, fibrinous exudate.

There have been many ingenious and useful devices for securing aspiration drainage which have given more or less satisfactory results in the hands of their originators, but no one method has been very generally adopted. Bülau,[1] at the Medical Congress of Vienna, in 1890, advocated air-tight drainage of acute empyema by means of a catheter introduced through the canula of a large trocar, which is inserted through an intercostal space. The canula is then withdrawn, leaving the catheter held tightly in place by the closely fitting soft tissues. The catheter is connected with a rubber tube which in turn is immersed in a bottle containing an antiseptic solution. This bottle being placed at a lower level than the chest, allows of siphon drainage. This method, with various modifications for retaining the catheter and rendering its fit air-tight, together with the addition of irrigation, has been used up to the present time, and lately has received added prestige from its successful and wide application in the epidemics of empyema following influenza, by Whittemore and others. It is a simple and extremely useful method. There are, however, certain disadvantages. (1) The calibre of the catheter being necessarily restricted, it is liable to become clogged. This may be obviated to a certain extent by systematic irrigation. (2) It is extremely difficult to maintain a hermetically air-tight joint for more than a few days at the most; after this time leakage occurs about the catheter, and it is then practically impossible to restore the original air-tight condition. (3) Any adjustment or changing of the catheter is very difficult. (4) If the lung is not readily dilatable, all the pus cannot be drained from the pleural cavity by this method, so long as the apparatus remains air-tight.

Forlanini,[2] of Pavia, pointed out the latter defect in the method, and

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[1] Bülau: Zeitschr. f. klin. Medicin, vol. xviii, p. 31, 1890.

[2] Forlanini: Policlinico, N. 100, 11, 12, 13, 1890.

advocated in 1890 preliminary thoracentesis with the introduction of air into the pleural cavity simultaneously with the evacuation of the pus, followed later by the institution of suction drainage by the method of Bülau. Forlanini insistently urged the advantages of producing artificial pneumothorax in empyema, not only in permitting complete evacuation of the effusion in cases in which the lung is bound down and the chest walls rigid, but in doing so without change of intrapleural pressure, and without arousing the so-called pleural reflexes of pain, cough, dyspnœa, etc. He also advocated inhalations of compressed air in the after treatment to aid in re-expansion of the lung.

R. W. Parker,[3] of London, had previously in 1882 advocated pneumothorax in the treatment of empyema, but his suggestion seems to have found little favor at that time.

Eugenio Morelli,[4] a pupil and assistant of Forlanini, who had worked for many years with the latter in the development of his therapeutic pneumothorax in phthisis, recognized the applicability of artificial pneumothorax in the treatment of wounds of the lung during the war, and devised an ingenious apparatus for the treatment of war wounds complicated by empyema, which has a useful application to the empyema of civil life. Having had occasion to observe Morelli's marked success with the empyema of war wounds, and subsequently having applied the method myself in a small number of cases of civil empyema with very satisfactory results, I feel that the method is worthy of consideration in a symposium on empyema.

Morelli has devised a pneumatic jacketed drainage tube (Fig. 1) which by inflation of the dumbbell-shaped soft rubber jacket closes the thoracotomy wound hermetically tight. This will remain tight for many days, is easily kept in place, and can readily be readjusted if for any reason the drainage is not satisfactory. It is held firmly in place by means of a spider (Fig. 2) made of thin malleable metal which fits over the pneumatic sac, the feet of the spider being adjusted to the chest wall. The drainage tube is passed through a central opening in the spider which is of slightly smaller calibre than the latter. The whole is covered with a layer of gauze and fastened by strips of adhesive. These drainage tubes were incidentally pictured in an article by Lieutenant Colonel Bastianelli on "Artificial Pneumothorax in Chest Wounds" in *Surgery, Gynæcology and Obstetrics* for January, 1919, p. 5.

The technic of the method is as follows: The diagnosis of empyema having been made, a preliminary thoracentesis is performed and the purulent exudate is withdrawn and replaced with an equal quantity of air by means of the apparatus depicted in Fig. 3.

This consists of a bottle of the capacity of a litre, closed by a rubber stopper which is perforated by two glass tubes, one of which is connected by rubber tubing to the thoracentesis needle, and the other with a three-way cock, which is in turn connected with a filter, consisting merely of a glass

[3] Parker, R. W.: Lancet, 1882, p. 689.

[4] Morelli: La Cura delle Ferite Toraco-polmonari, Bologna, 1918.

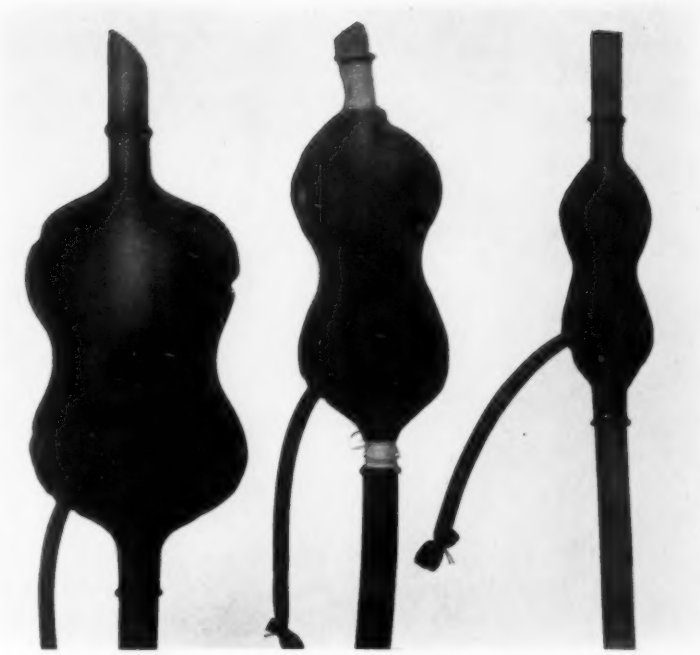

FIG. 1.—Pneumatic jacketed drainage tubes—three sizes.

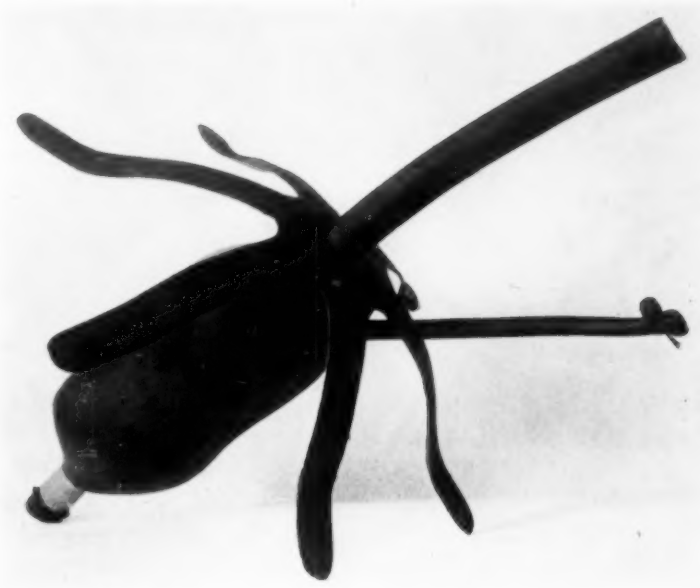

FIG. 2.—Metallic spider for holding drainage tube in place.

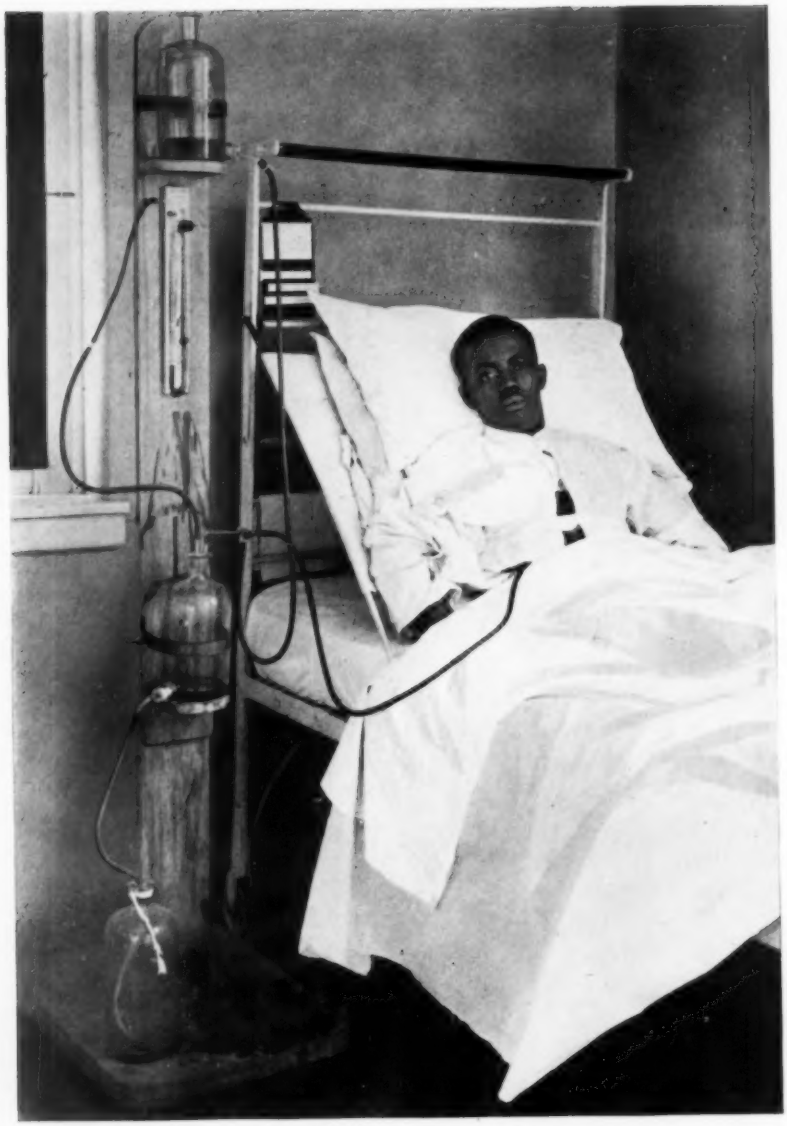

FIG. 5.—Apparatus set up.

tube filled with sterile cotton, and finally a syringe of at least 100 c.c. capacity with a perfectly fitting piston.

The apparatus is operated as follows: Having been sterilized and the joints made tight, the large thoracentesis needle is introduced into the chest and the connection between the bottle and the syringe being open, a suction stroke is made with the piston of the syringe; this produces a rarefaction of the air contained in the bottle, and results in the flow of the fluid in the chest into the bottle to replace the displaced air. When the flow of the fluid begins to subside, a reverse stroke is made with the piston of the syringe, forcing the air in it back again into the bottle, whence, finding its place taken by the fluid, it will be obliged to pass on into the pleural cavity, where it will be distinctly heard gurgling through the pleural effusion as it rises to its upper surface. When the gurgling ceases a new aspiration is made with

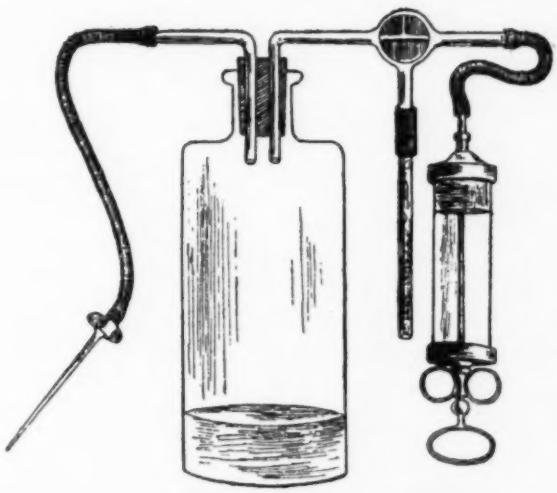

FIG. 3.—Thoracentesis apparatus.

the syringe, followed by a new insufflation of air into the pleural cavity, and so on, until all the fluid has been evacuated from the chest, or the bottle is completely filled with fluid, all the air which it previously contained having entered the pleural cavity. When one bottle is full another may be substituted, and the process repeated. The three-way cock and filter come into play when it is desired to put in a greater quantity of air than the amount of fluid extracted, or, vice versa. With this method, if the air is warmed to body temperature, there is absolutely no change in the intrapleural pressure, and no modification of the cardiac condition results. There is no danger of œdema of the lung, nor sudden rupture of pleural adhesions, no sense of constriction nor other pain, no cough nor stimulation of the pleural reflexes; in fact, no untoward disturbances of any kind.

Morelli strenuously advocates this method of thoracentesis for all pleural transudates and exudates of whatever nature, claiming, with much logic, in

addition to the advantages already enumerated the much lesser likelihood of a reaccumulation of fluid, than when aspiration is done by the ordinary method, which greatly increases the negative pressure of the pleural cavity.

Having replaced the pus of the empyema with an equal amount of air, on the following day a thoracotomy with resection of a square piece of rib is done under local anæsthesia, and the previously described pneumatic drainage tube inserted and connected with the apparatus in Fig. 4, consisting of a wooden stand upon which are set three bottles. The upper bottle is for

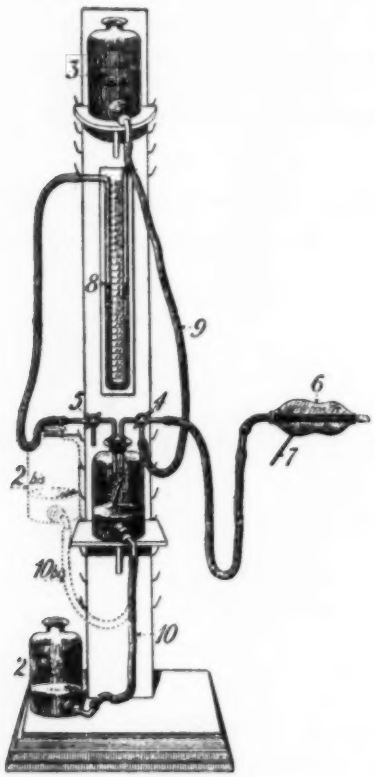

FIG. 4.—Empyema apparatus.

the purpose of irrigation. The middle bottle placed at about the level of the bed is connected directly with the drainage tube, and is partly filled with an antiseptic solution; it is connected by a tube at its bottom with a third bottle set at a lower level, and aspiration drainage is exerted by the difference in level of the fluid in the two bottles. In the case of a recent war wound of the lung complicated by empyema, Morelli maintains at first drainage with positive pressure in the pleural cavity by raising bottle (2) to the position of (2 bis) in the cut, above the level of bottle (1). For ordinary cases of civil empyema this is not necessary, and negative pressure is exerted at once by lowering bottle (2) to a point corresponding to the amount of

negative pressure desired. A manometer is connected with bottle (1), by a three-way cock at (5), which registers the negative pressure in bottle (1), as well as in the pleural cavity. There is a three-way cock also at (4), which allows of irrigation, which is useful in clearing the tubes of coagula of fibrin, or inspissated pus.

This apparatus, which seems somewhat complicated, works very well in practice. It can be seen at a glance whether or not the drainage is working, and irrigation may be carried on with great ease and perfect cleanliness. For practical purposes the whole thing may be greatly simplified by merely connecting the pneumatic jacketed drainage tube with two bottles containing liquid at different levels, one standing on a chair, and one on the floor, cutting out three-way cocks, manometer, and irrigation bottle, which are unessential accessories.

The advantages of this method are, that not only can large fibrinous clots be removed directly at the time of operation, but a drainage tube of larger calibre than the trocar method permits of can be used, so that subsequent obstruction of the drainage is less likely. Furthermore, air-tight drainage can be maintained for a longer period of time, as the pneumatic jacket of the tube adjusts itself to the wound and does not tend to work loose; it causes no necrosis of the tissues, but bright granulations spring up along the tract of the wound, which heals promptly when the tube is removed. It is at all times surprisingly comfortable It is especially adapted to cases in which there are fibrinous clots which so often clog the tubes of small calibre, and in cases in which through delay in operating tough adhesions have formed which will require somewhat prolonged aspiration for the complete re-expansion of the lung.

If it is inconvenient, as is often the case, to do a preliminary thoracentesis with induction of artificial pneumothorax, in my opinion the same benefits may be obtained, with practically negligible risk, while performing the operation at one sitting. It is only necessary to exercise care in allowing the pus to escape very slowly from the chest by making at first a small opening in the pleura, which can be controlled by digital pressure, preventing at the same time the rapid and tumultuous entry of air which is as much to be avoided as is the forced expulsion of pus.

For cases in children, or in recent cases in which the effusion is thin and of a turbid serous nature, the trocar and catheter method is quick, simple, and entirely adequate; the importance, however, of replacing the withdrawn purulent exudate with air, so as to allow of the complete evacuation of the former, as insisted upon by Forlanini and Morelli, should be borne in mind. This can be accomplished by means of the thoracentesis apparatus of bottle and syringe of Fig. 3, which should be connected with the catheter as soon as the latter is introduced into the chest, and negative pressure instituted later by means of the two-bottle method. If the lung is fully dilatable no harm is done by introducing the air, which will readily be sucked out again by the apparatus. Simple siphon drainage, however, will not suffice for this,

as the siphonage will be broken by the column of air in the tube, which will not affect, on the contrary, the two-bottle method.

The value of irrigation with Dakin's solution, or other antiseptic, in empyema is emphasized by Morelli, and is now generally recognized. Apart from its antiseptic value it is of special importance in all cases of air-tight suction drainage in keeping the tubes free from plugging. Care must be taken to introduce only small amounts of fluid at a time, and to make sure that as much returns from the chest as is put in.

The features of the Forlanini-Morelli method in the treatment of empyema are in brief: the systematic induction of pneumothorax, continuous aspiration drainage combined with irrigation, and an air-tight pneumatic jacketed drainage tube of great value in appropriate cases.

ABSCESS OF THE LUNG*

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There exists in the literature some confusion as to the lesions included under the term abscess of the lung. In this communication a definition is employed which it is believed accurately describes the lesion, and at the same time is comprehensive enough to include the associated necrosis which so often is a part of the lesion.

Abscess of the lung means a collection of pus within the destroyed lung parenchyma; that is, it must be outside the lumen of the respiratory tree. Dilatation of the bronchi with a purulent inflammation of the mucosa and an excessive expectoration of foul sputum is not to be confused with abscess. This lesion—bronchiectasis—may coincidently be present, but is not necessarily so. Surrounding the abscess—really a portion of its wall—there often exists a destruction of lung tissue which may be somewhat massive and approach gangrene. One must, to a certain extent, be empiric in delimiting this lesion from a true gangrene. When the condition has resulted from bacterial invasion, *via* the respiratory tract, and is early manifest by the suppurative process, the term gangrenous abscess is accurately descriptive. Gangrene should be reserved for a massive destruction of lung tissue, either from true circulatory disturbance, or from such an overwhelmingly virulent infection that the lung tissue is killed in mass by toxins or vascular plugging before there can be a sufficient reaction to generate pus. If this division be followed, the number of cases of lung gangrene reported will be materially lessened, and a better understanding of the pathological processes be possible.

A case of true gangrene—the only one coming to my personal attention—has recently been reported to me through the courtesy of Dr. Lincoln Davis, of the Massachusetts General Hospital. A child received a penetrating wound with a crochet needle into the upper right lobe of the lung. Two days later she began to suffer pain and marked swelling around the site of puncture which rapidly increased up to the time of her admission to the hospital, one week after the injury. She was then very sick, the manifest signs being an emphysematous cellulitis in the neck and upper chest, with evidence of a hæmo-pyo-pneumothorax. Thoracotomy was performed. Death occurred the following day. Autopsy showed the entire upper lobe of the lung converted into a necrotic sac containing brownish opaque fluid. There was neither the surrounding inflammatory zone nor the pus content of an abscess formation.

Dr. Albert Frost, of the Interne Staff, has made the following sum-

* Read at a joint meeting of the New York Surgical Society and the Philadelphia Academy of Surgery, February 2, 1920.

mary of autopsy findings from the protocols of six thousand autopsies at Bellevue Hospital for the purpose of studying the relations in this type of lesion. There have been 148 cases with the anatomical diagnosis of lung abscess and gangrene of the lung. Abscess and gangrene are included in this summary under one head, because of the fact that so many of the cases of so-called gangrene of the lung cannot be differentiated from abscess.

Of the 23 cases with an anatomical diagnosis of gangrene, only 7 could be definitely spoken of as a true gangrene from the descriptions.

Of these 148 cases there were 50 which should be regarded as clinical abscesses, in that the abscess was of such size that it could have been detected before death, either by physical examination or by X-ray. Of these clinical abscesses there were 25 situated in the upper lobes, 22 in the lower lobes, and 3 in the middle lobe.

Other interesting data are briefly summarized in the following table:

Subpleural abscesses associated with empyema	34 cases
Abscesses mentioned as having ruptured into the pleura in which there was an accompanying empyema	12 cases
Empyemas mentioned as draining through the trachea	2 cases
Abscesses mentioned as rupturing into bronchi	15 cases
Pus from abscess mentioned as having foul odor	47 cases
Abscess result of necrosis of infarcted area	17 cases

The etiological factor in the production of these abscesses, including both the clinical and pathological lesions, was, so far as possible, determined from the associated autopsy findings. Only those cases in which the cause was evident are included in the following:

Bronchopneumonia	29	Septic endometritis	7
Lobar pneumonia	18	Infective endocarditis	6
Pyæmia	15	Acute suppurative otitis media	5
Septicæmia	11	Thrombosis pulmonary artery	4
Thrombosis in peripheral venous channels (sinus, jugular and inferior vena cava)	8	Purulent bronchitis (cause or effect)	3
		Tracheotomy	2

In the literature the differentiation between abscess and gangrene is often made from the odor of the sputum and the pus. Exceedingly foul pus is made to connote a gangrene without regard to the pathology. This, obviously, is incorrect, as is proved by the clinical and pathological cases described. In several of these the pus was stinking, and yet the evidence is conclusive that no true gangrene was present.

While abscess of the lung may result from other sources, the great majority have as a direct antecedent some type of respiratory infection, if, in such infection, the aspiration inflammations be included. In the literature the statement is found that among these the true pneumococcus lobar pneumonia is the most common antecedent. We have not found this to be the case, either actually or relatively. Of 13 cases, associated with a pulmonary infection, observed clinically, 10 of which will be analyzed

in detail, only 3 followed this type of infection. What is still more significant, in each of these three, secondary invaders were found in the abscess content, and the pneumococcus apparently had no part in abscess formation.

MacCallum, in a personal communication, says, " I am skeptical about those abscesses said to occur in the course of a pneumococcus lobar pneumonia. At least, they never look like abscesses, but like areas of more advanced destruction with no special limitation." He expresses the belief that even these are due to secondary invaders; an opinion amply sustained by our study.

In 770 consecutive cases of pneumococcus lobar pneumonia admitted to the Rockefeller Hospital, only 2 developed lung abscess, and each of these showed other infecting organisms. One of them completely recovered from the lesion in the lobe first involved, and later the abscess containing no pneumococci, formed in the other lung, in a part where the evidence of lobar pneumonia was very recent and scant. In this series there were two others showing a pneumococcus infection, but the diagnosis of a lobar pneumonia could not be substantiated by the physical signs or the radiograph. During the same period there were 140 cases of bronchopneumonia admitted, one of whom developed a lung abscess.

The entire number of abscesses observed in this hospital has been 9, the remaining 6 being divided as follows: 2 followed previous tonsillectomies with mixed infections; 1 occurred primarily with a staphylococcus aureus infection; 2 occurred primarily with a very mixed bacterial infection, and 1 resulted as a late manifestation of a staphylococcus aureus pneumonia. Our studies lead to the conclusion that the staphylococcus aureus is an important agent in abscess formation.

Great interest attaches to the subject of the pathogenesis of the abscess. In this connection the recent studies of Cecil and Blake are important. These authors found in their studies of the pathogenesis of pneumonia and other pulmonary infections that the inflammation in the lung parenchyma, following injections of virulent cultures into the trachea of monkeys, preceded by some hours the exudation in the air vesicles.

Inasmuch as the infecting organisms must sooner or later invade and break down this interstitial tissue, if an abscess is to result, this very early invasion throws light on the occurrence of a primary abscess, that is, pus formation before there is any pneumonic consolidation. In fact, in some cases, such consolidation may never appear. More often, however, the presence of a true consolidation may be demonstrated. The changes from this condition with the vesicular exudate and the interstitial inflammation to abscess formation are to some extent elucidated by the study of the pneumonic lung, particularly when there exists a mixed bacterial flora.

Many cases of pneumonia coming to autopsy exhibit areas in which

the interstitial spaces are packed with the products of the pneumonic inflammation, the vesicle walls are more or less destroyed, and the lung substance is converted into an acutely inflamed zone showing foci of necrosis. In many instances these foci have progressed to a farther stage and liquefaction is present, *i.e.*, a beginning abscess (Figs. 1 and 2). The majority of such foci are very small, and while pathologically they are abscesses, this could not have been determined clinically. It is to be assumed that, had such cases survived, there would have occurred, in some, at least, a farther development, and clinical evidence would have been present. Chickering and Park found in the lungs of patients dying from staphylococcus aureus pneumonia, multiple abscesses varying in size from a millimetre to a centimetre. The content varied from a necrotic mass to a thick, greenish, yellow pus. In no instance was the abscess large enough to have given clinical signs.

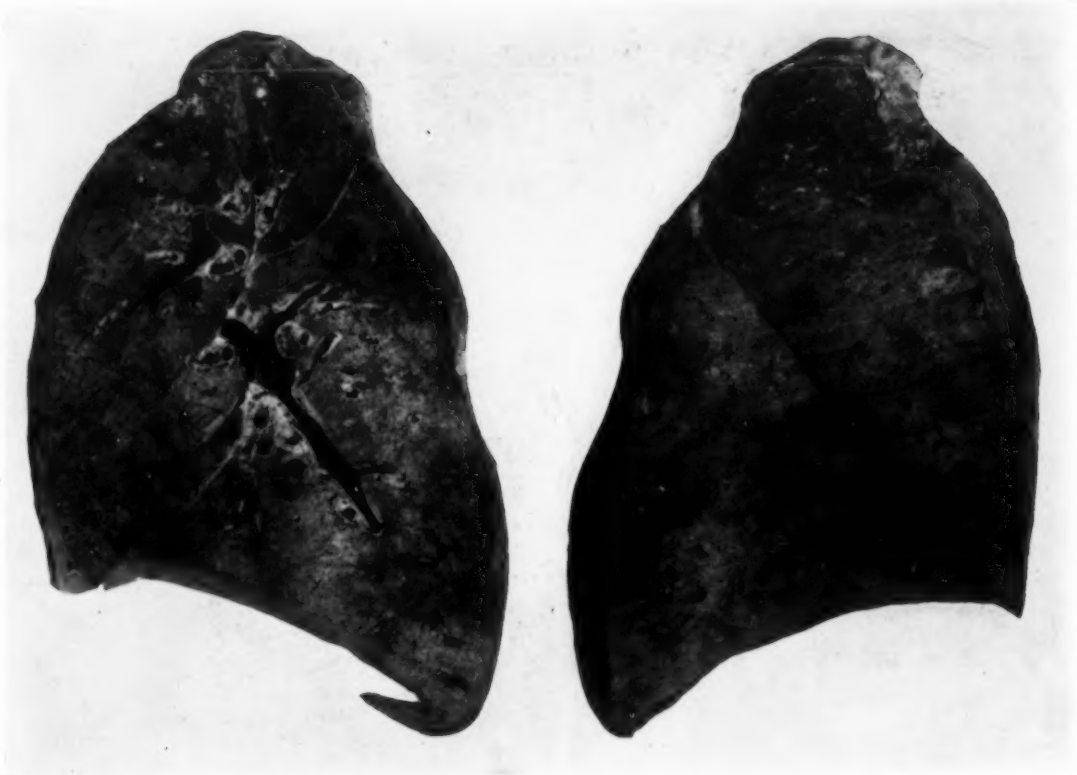
All these studies emphasize the belief that lung abscess is a very important possibility much more often than is realized. We have no knowledge of how frequently these small focal abscesses form and undergo resolution and drainage, but this evidence is in favor of its frequent occurrence. We are not informed as to the causes which bring about their continued growth into large abscesses. One is compelled to fall back upon the unknown factor of resistance and virulence, with, in addition, the factor of a better or poorer drainage *via* the bronchioles. Study of the bacteriology yields the information already mentioned. Abscesses are encountered clinically, following all types of pneumonia, but the rule is to find a secondary invader, such as staphylococcus or streptococcus, occurring alone or in conjunction with the influenza bacillus. All these organisms have been found in the sputum of patients suffering from lung abscess. On the other hand, all types of lung infections regularly occur without the development of lung abscess. The clinical facts on which to base a belief that the ordinary pyogenic bacteria, particularly the staphylococcus aureus, are more prone than other organisms to produce a lung abscess are given above. It is to be emphasized that a staphylococcus aureus infection may produce an abscess without a true pneumonia. A well-marked abscess may occur almost with the inception of this infection, and be fully developed within a few days of the onset of the illness. Such a lesion is the primary lung abscess already mentioned.

There is, in every case of abscess, an exit for the fluid pus *via* the vesicles and small bronchioles. This drainage, however, is often inadequate, and following the law of all suppuration, the process extends along lines of least resistance. Abscess cavities, from five to ten centimetres in diameter, up to an entire lobe, may thus be formed. A fluid content of several hundred cubic centimetres is not uncommon. Ultimately, a larger bronchus is opened to it, drainage is free, and the complete pathological picture of the abscess is present. Often several large bronchial openings into the abscess are present.

FIG. 1.—Lobar pneumonia, showing the areas of necrosis, which are the starting points of abscess.

FIG. 2.—Influenza pneumonia, showing a necrosis beneath the pleura with a nearby large bronchus. This type of lesion going on to abscess formation may also produce an empyema which will drain through the abscess cavity and the bronchus.

FIG. 3. FIG. 4.



FIGS. 3 and 4.—A lung distended to the normal inspiratory extent and hardened in formalin. Fig. 3 shows the large bronchi ("drainage tubes") at the junction of the middle and deep thirds, while Fig. 4 shows the absence of these at the junction of middle and superficial thirds.

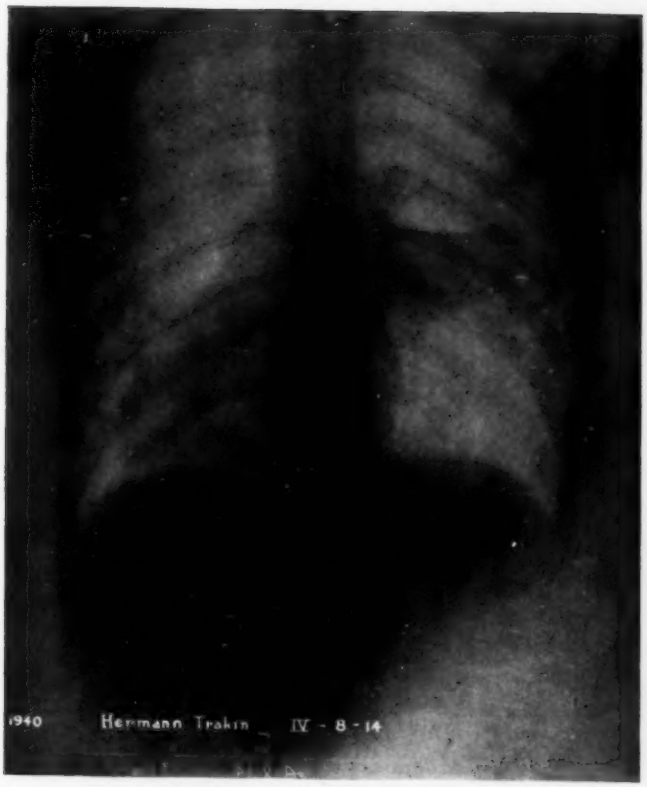
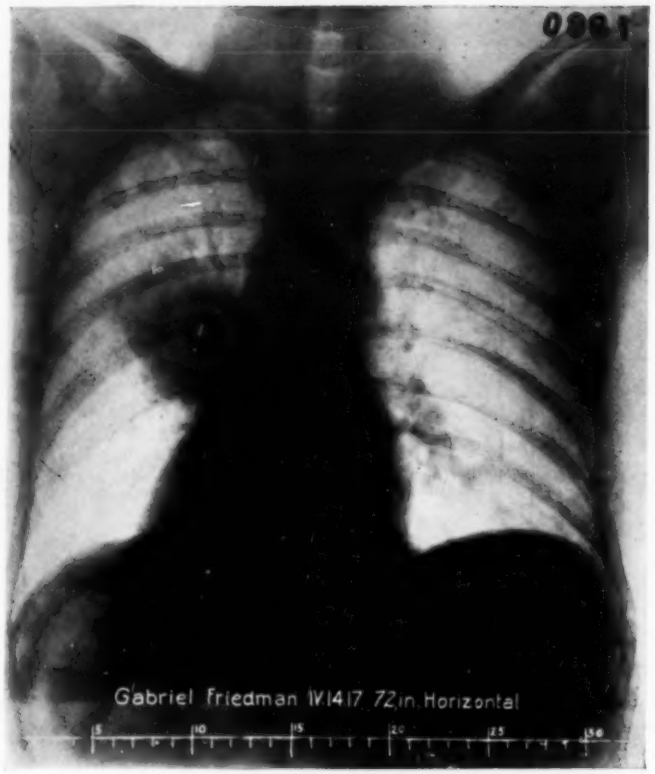


FIG. 5.—A typical shadow of an abscess cavity containing pus below and air above.



FIGS. 6 and 7.—A deep-seated staphylococcus abscess slowly working toward the anterior wall in spite of free bronchial drainage.

An abscess in the more superficial parts of the lung tends to reach a considerable size before it lies in relation to a bronchus of sufficient lumen to afford an avenue of adequate drainage. In the deeper parts, on the other hand, such bronchi are more numerous, and it is possible for drainage to be more complete (Figs. 3 and 4). This is an important fact from a therapeutic standpoint. It also has a most important bearing, as we believe, upon the occurrence of empyema and its occasional drainage through the lung and trachea.

When the abscess is fully established, as seen, for instance, at operation, its wall is a ragged surface of necrosing lung tissue around which, microscopically, are found œdema, leucocytes, dilated and thrombosed blood-vessels and bacteria, all of which pack the air vesicles as well as the interstitial space. Its outline is often irregular, giving the impression that several foci of suppuration have coalesced into one abscess. Between these diverticula the lung substance may be dead in considerable areas. When the infecting organisms are unusually virulent a surrounding gangrenous condition may supervene. Putrefactive organisms gaining entrance from the mouth to such areas produce a putrid mass. Such lesions are not uncommon, and should be designated as already discussed, as gangrenous abscess rather than lung gangrene.

Since, whatever the cause of the abscess, there exists an antecedent inflammation, the surrounding zone is always well marked. It is emphasized in abscesses secondary to the pneumonic infections, because such abscesses occur in portions where resolution has been incomplete and the interstitial inflammation is marked. In studying the physical signs of abscess formation and in reading radiographs, this zone must be given due consideration. It often acts as a very troublesome mask to a proper diagnosis.

The following case[1] illustrates the pathological and clinical development of an abscess as the sequela of a true lobar pneumonia, where the pus formation was due to a mixed infection.

> On February 6, 1914, the patient, a male, aged forty-two years, developed a left upper lobar pneumonia with typical signs and X-ray findings. The sputum was rusty from the onset. On admission two days later there was isolated from the sputum a Gram-positive diplococcus, a Gram-negative capsulated bacillus, the Friedlander and the influenza bacillus. On the fourth day of the disease there was elicited a flat note over the centre of the consolidation. Resolution and deffervescence failed, and on February 21st there were made out the signs of cavity formation, but the X-ray failed to demonstrate any change in the shadow.

[1] All the clinical cases herein reported, with the exception of the last one, were observed and treated at the Rockefeller Institute Hospital. I desire to express my thanks to Dr. Rufus Cole for the privilege of having treated them and including them in the report.

On February 27th there appeared the first expectoration of pus, 250 c.c., from which the same organisms as found in the early sputum were isolated. The physical signs and the X-ray now fully demonstrated the presence of a cavity in the centre of the upper left lobe. His general condition remained excellent and operation was delayed until March 7th with the hope that sufficient drainage, *via* the trachea, might result in a cure. This failing, the surgical procedure followed in all the cases was undertaken. The exact position of the cavity was determined with the exploring needle, and under novocaine anæsthesia a portion of the underlying rib—in this case the fourth to the left of the sternum—was resected. The two pleural surfaces being found adherent, they were incised, and by blunt dissection the abscess cavity was opened. It was about 10 cm. in diameter and pathologically showed the typical lesion described above. The pus contained the organisms above named, with the exception of the pneumococcus. Tube, and later vaselined gauze, drainage was established, and healing was complete on May 8th.

The course of the abscess development is in this case sufficiently clear by reference to what has already been said. The severity of the interstitial infection produced a local inflammation which failed of resorption (Figs. 1 and 2), and in the course of two weeks pus formation was present, and a week later a bronchus of sufficient size for internal drainage was opened into.

This case contrasts quite sharply with the following, who developed a well-marked left lower lobar pneumonia on April 20, 1914. On admission three days later the sputum showed a pneumococcus and a Gram-negative bacillus. The process in this lobe went on to a normal resolution on the seventh day, with a normal temperature. On April 25th, however, pain and friction râles developed over the right upper lobe. On May 5th the temperature rose to 103.4°, and signs of consolidation developed in the right lung anteriorly. An exploratory needle puncture in the third space, 5 cm. from the right edge of the sternum, entered a pus and air cavity. Cultures from the pus gave a pure growth of hæmolytic staphylococcus aureus. Operation showed an abscess which was multilocular, each focus containing only a few c.c. of pus with an extensive surrounding zone of necrotic lung. A cure resulted in about two months.

This case illustrates the rôle of the staphylococcus aureus in abscess production. The lobe first attacked followed the normal course of a pneumococcus lobar pneumonia, but another lobe attacked by the staphylococcus promptly passed into the suppurative condition and developed an abscess.

A third case presents still another phase of the subject.

The patient, a male aged twenty years, was admitted to the hospital on April 11, 1914, with the history of having had a cold for

two days and a chill and sudden pain in the right chest two days before admission. He suffered from a dry cough with occasionally the expectoration of a little mucopurulent sputum, which contained a non-hæmolytic streptococcus, a pneumococcus, and a Gram-negative bacillus, the latter predominating. There were no evident signs of consolidation made out at any time during the nine days he remained in the hospital. The temperature ranged from 100° to 102.8°, pulse about 80, and respirations 30. The X-ray on the third day following the chill showed a denser shadow corresponding to and extending immediately around the right hilus.

On the ninth day of the disease there occurred free expectoration of 100 c.c. of brownish-gray pus which contained characteristic elastic fibres arranged partly in alveolar form. These were recovered from a mouse inoculated with this pus: (1) Pneumococcus mucosa, bile soluble. (2) Pneumococcus IV. (3) Streptococcus hæmolyticus. (4) B. Influenza.

The X-ray (Fig. 5) now shows a distinct abscess cavity with a very limited surrounding zone of consolidation containing free fluid and air. This cavity was not determined by the physical signs.

An exploration needle introduced deeply into the substance of the lung through the sixth space, near the angle of the right scapula, withdrew pus of the same character and containing the same organisms. The patient declined operation and made a complete recovery.

This condition in which the abscess is an early manifestation of a deep-seated lung infection is contrasted with the more superficial abscesses. In the former the drainage may prove adequate because of the immediate vicinity of the large bronchi which act as efficient drainage tubes. In the latter extensive destruction of lung tissue must take place before such tubes are reached, and hence spontaneous recovery is less possible (Figs. 3 and 4). Not all deep-seated cases escape without operation, however, as is shown by the following:

A man, aged thirty-six years, was admitted to the hospital April 13, 1917. Two weeks prior to admission be caught cold and had a sticking pain in the *right* chest. He states there was cough and bloody sputum, but no fever. He was only absent from work for three days. A few days later there was a recurrence of illness with severe coughing, blood-tinged sputum, and sticking pain in the *left* chest. There was no chill and he states no fever until four days prior to admission. No history of having inhaled any irritating gas or foreign body could be obtained.

The physical examination revealed a soft friction rub in the left axilla, and below the angle of the scapula posteriorly there was a slight exaggeration in whisper. Elsewhere the lungs showed no abnormal signs. The remainder of the physical examination was negative. No portal of entry for infection could be found. Blood culture was sterile with 10 c.c. in 150 c.c. broth and 2 c.c. on 10 c.c. agar plate.

The patient appeared acutely but not seriously ill. Temperature, 102.8°; pulse, 95; respiration, 28; white blood-cells, 40,000. The only change in the general condition or physical signs, until the seventh day of illness, was the development of slight dullness over the left mid chest posteriorly. On that day there was severe coughing and suddenly purulent sputum was expectorated in very large amounts. It was greenish brown in color. Smears showed many varieties of bacteria. Injected into a mouse it yielded staphylococcus aureus in the heart's blood. Dullness with sonorous and sibilant râles were present over the left mid chest anteriorly.

Diagnosis of lung abscess with free bronchial drainage was made. It probably was of staphylococcus origin and lay deep within the middle portion of the left lung. The patient was kept under observation for ten days, because his general condition remained satisfactory, the abscess was draining freely and a serious question was present as to whether the better operative approach was from before or behind.

During this period the temperature ranged from 100° to 102.5°. Pulse 80 to 100. Respiration 22 to 32, and the blood count 40,000 to 50,000 with about 88 per cent polymorphonuclears. The physical signs changed only in that dullness developed anteriorly over the left mid chest and percussion here elicited tenderness. The sputum was abundant, 190 c.c. on one occasion. It was almost pure pus, greenish in color, with tinge of blood, and of very foul odor. Staphylococcus aureus was recovered from the heart's blood of the mouse on several occasions following injections of purulent sputum. No source of a staphylococcus aureus could be found anywhere in the body. No tubercle bacilli were found.

The X-ray plates showed the development of the abscess and its approach to the anterior chest wall. They gave no evidence of a pneumonia or a tuberculosis (Figs. 6 and 7). The exploring needle inserted about the eighteenth day of the disease in the third intercostal space, at the outer border of the left pectoral muscle, entered the cavity and withdrew very foul, thick, brownish pus.

Under local anæsthesia 6 cm. of the third rib at this point was resected and immediately beneath the two layers of the densely adherent pleura and a thin shell of remaining lung tissue was found an abscess cavity 15 cm. in diameter contatining about 250 c.c. of the same foul pus. Internally, the cavity seemed to be bounded by the pericardium, but on all other surfaces there was comparatively healthy lung tissue. The pleural cavity was not infected. The abscess was in the inferior portion of the upper lobe. So far as could be ascertained the post-operative behavior of the lung condition was satisfactory. Drainage continued free and there was no other evident involvement of lung tissue. The patient, however, lost weight and strength, refused to eat, and died without evidence of sepsis three weeks following operation. No autopsy was granted and the immediate cause of death was not determined.

This case is of the type of primary abscess with the staphylococcus aureus as the exciting organism. The X-ray (Fig. 6) failed to show the usual shadow of a pneumonic consolidation. The abscess ruptured into a large bronchus with a resultant expectoration of a large amount of foul pus on the seventh day of his illness which is too early for the development of the abscess through a preceding stage of consolidation. Notwithstanding the deep-seated position of the lesion, and its early drainage by the tracheal route, it continued to extend toward the pleural surface, and obviously was not destined to recover without external drainage.

From the early sticking pain in the left chest and the friction rub heard in this axilla, it is evident that the original infection involved superficial as well as deep portions of the lung, but with not sufficient lesion to cast a shadow with the X-ray.

Suppuration occurred first in the more seriously damaged central portion and later extended into the superficial part where drainage was less complete. This was proved by the fact that at operation the two pleuræ were adherent and thickened, although the abscess itself was still situated some distance below the surface.

Other organisms than the staphylococcus aureus are capable of producing a pathological condition with similar clinical manifestations to those just mentioned, as is shown in the case of a man aged twenty-eight years who was admitted to the hospital on April 6, 1914. His illness began on April 2d with a chill and pain in the right chest behind. He immediately (?) began to expectorate large amounts of foul pus.

The physical signs were not marked, though some dullness existed with diminished fremitus and breath sounds over the lower right chest behind.

Two days after admission—the sixth day of his illness—an exploratory puncture deep into the right lung yielded very foul pus. Operation revealed a markedly inflamed lung with many small abscess cavities underlying the adherent and thickened pleuræ. The whole area of disease was evidently undergoing a breaking down suppurative process. The responsible organisms in this case, as determined both from the sputum and the pus, were Gram-positive cocci, Gram-negative fusiform bacilli, Gram-positive diplococci, and a short-chained coccus. The Gram-negative organisms were obtained only under anaërobic conditions. Healing was delayed until the twelfth week, owing to the presence of an open bronchial fistula, which only closed after nine weeks.

A case of true staphylococcus aureus pneumonia, with resultant multiple abscess formation—the type described by Chickering and Park—going on to recovery without operation, is illustrated by the following. A man, aged twenty-four years, was admitted to the hospital with this history. His illness began with an ordinary cold, after three days of which the patient had a chill and severe pain in the right side of the chest. He was admitted to the hospital

fifteen hours later. At this time he appeared very sick. Temperature, 105°; pulse, 124; respiration, 34; lips cyanotic. Examination showed evidence of a beginning consolidation in the right axilla. Sputum on culture yielded a pure growth of hæmolytic staphylococcus aureus. Blood cultures were negative.

On the fourth day of his disease, which followed the course of a severe pneumonia, the patient coughed up a mass of homogeneous, hemorrhagic sputum, swarming with staphylococci. The condition continued unchanged up to the eighth day. Exploratory puncture then yielded 10 c.c. of thick, grumous, chocolate-colored pus, smears of which showed only staphylococci.

On the thirteenth day the patient first began to expectorate freely pure pus, but in small quantity, after which there was a suggestion of amphoric breathing and loud râles in the posterior part of the right axilla. He remained acutely sick during this period, and developed foci of suppuration in two of his fingers and also in the chest around the site of the needle puncture. Other punctures into the lung were done on the twenty-first and twenty-seventh days, but in each instance the needle, as at the first puncture, passed into very solid lung tissue and only withdrew a few drops of pus, and in one instance entered a foul-smelling air cavity. During this period the amount of foul, purulent sputum gradually increased, but was not excessive until the thirty-fifth day, when, after coughing, there was a sudden gush of very foul-smelling pus which was projected outward like vomitus. From this time forward the progress was satisfactorily toward complete recovery, there being a gradual healing of the lung process. Complete recovery was established on the ninety-second day of his disease. Operation was deemed unwise in this case, because the process was an unresolved staphylococcus pneumonia with many small necrotic foci with which surgery would have found great difficulty in dealing. When the large abscess finally developed it promptly reached a large bronchus and a change toward recovery was immediately instituted.

Mention has been made of the relation of empyema secondary to abscess formation, and subsequent drainage of both the abscess and the pleural suppuration through the tracheal tree. I incline to the belief that this is the usual sequence of events when an empyema drains in this way. An abscess of considerable size develops in the superficial part of the lung, and failing to reach any bronchus of size, there is no expectoration of pus. Such a lesion gives no physical signs to differentiate it from the surrounding consolidation, and so is not diagnosed. In its extension it finally reaches the pleural surface, ruptures through, and produces a secondary empyema. The physical signs of the latter completely mask the abscess, and the case appears as an empyema only. The extension of the abscess, however, is also toward the deeper portion of the lung, and in this direction a large bronchus is ultimately reached, and there results a free expectoration of pus. This is interpreted as the "rupture

of an empyema" into the lung which is obviously an incorrect deduction. The actual lesion is a lung abscess reaching an outlet in two directions—first, into the pleura, and second, into the bronchus. Often expectoration of pus is not a marked feature, and operation on the empyema is undertaken prior to this secondary exit. The communication into a bronchus, however, exists, and following operation, one essential for the cure of the empyema is lacking, namely, the coincident expansion of the lung as the suppuration in the pleura is overcome. The open bronchus produces a continued internal pneumothorax, the lung fails to expand, and cure of the empyema is delayed long after the proper interval. This is often one of the underlying causes of persistent sinus following an operation for what was believed to be a simple empyema.

The employment of Dakin's solution for cleansing the pleural cavity after rib resection has demonstrated the presence of these coexisting lesions not infrequently. When present, the patient promptly smells and tastes the chlorine, and in many cases violent pulmonary irritation is set up with uncontrollable coughing. This never results when this solution is used in a simple uncomplicated empyema. Its appearance is proof that one is dealing with the condition under discussion, and in my belief, the use of Dakin's solution must never be continued, no matter how efficient one may have found it in the uncomplicated cases.

This occurrence of an empyema masking completely the presence of a large abscess of the lung was illustrated by two cases in this series.

In the first the illness began with pain in the right chest and the expectoration of foul pus. He was admitted to the hospital two weeks later, during which time the later symptoms had continued.

Examination by exploratory puncture showed that the right chest contained thick, yellowish-green, foul pus, similar in appearance to the sputum. Both contained Gram-positive and Gram-negative cocci and Gram-negative bacilli. Injected into a mouse there were isolated Gram-positive diplococci with large capsule (pneumococcus mucus). The exudate agglutinated with antipneumococcus serum III. The X-ray showed the shadow of a pleural effusion. Operation revealed a large abscess containing very foul pus in the middle of the right lower lobe. There was also a very thick fibrous purulent exudate in the pleura overlying this. The patient recovered, but still had a small clean bronchial fistula when last reported.

The second case is of unusual interest. The patient, an officer, aged twenty-three years, with the A. E. F., developed an arthritis in August, 1918, while on duty in the advanced zone. At about the same time he was slightly gassed with chlorine. He was sent to a rear hospital where, on September 15th, under local anæsthesia, a tonsillectomy was done. A month later he suffered from an attack of influenza and pneumonia. There is some evidence that prior to this he was ill with a pulmonary infection and at times expectorated pus, sometimes a "half cupful in a day." He remained ill through

the winter and was finally operated upon in March, 1919, for empyema. He was told that two quarts of pus were evacuated. Dakin solution was instilled into the pleural cavity on one occasion and he continued to "taste it for a week," so that it was not employed a second time. In the course of ten weeks the operative wound closed. On June 30, 1919, the X-ray and the physical signs showed that he had a complete pneumothorax, the lung having contracted to a small mass near the root and along the left border of the pericardium. The operative wound was still closed and he was without constitutional symptoms.

In August, 1919, he became acutely ill and coughed up large amounts of somewhat foul pus. There was no pus in the pleural cavity as demonstrated by exploratory puncture, though after four weeks the sinus opened and for a short time there was a moderate discharge. The sinus closed, the pus expectoration ceased, and in December an X-ray showed the lung expanded to fill almost the entire chest. There was a recurrence of purulent expectoration in January. At this time the X-ray and the physical signs demonstrated a cavity in the middle of the left lung posteriorly. The expectoration subsided in three or four weeks, and in April an X-ray and the physical examination failed to demonstrate any cavity formation.

The course of the disease in this case seems to have been an abscess, probably following the tonsillectomy, which ruptured into the pleura, producing the empyema. This was operated upon and the opening closed, but the lung failed to expand because of the internal pulmonary fistula which kept up a continued pneumothorax. This condition is evidenced by the fact that the chest wall instead of retracting, as is usual with a collapsed lung, expanded to a marked degree, as is amply illustrated in the X-ray by the wide separation of the ribs, a finding called to my attention by Dr. Codman, of Boston.

Subsequently the abscess discharged through the trachea, its fistulous opening closed, and gradually the lung expanded to its full extent with a resulting cure of the complex lesion.

The infecting organism in this case was found in every instance to be the streptococcus hæmolyticus.

This analysis of these pathological and clinical observations is believed to fully justify the findings included in the introductory remarks, namely, that the pneumococcus is not an important factor in lung abscess; that the staphylococcus aureus is often responsible; that abscess of the lung frequently is a primary lesion in that a true pneumonic consolidation as connoted by the name pneumonia does not precede it; that abscess of the lung includes in its pathology a marked degree of surrounding necrosis, or even massive gangrene, and that when an empyema ruptures into the lung and discharges through the bronchus the original lesion was a lung abscess which, by its extension, finally found two outlets for its purulent content.

THE TREATMENT OF BRONCHIAL FISTULÆ*

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A bronchial fistula, as its name implies, is a communication between a bronchus and the outer surface of the lung. It may be the only condition for which a patient comes under treatment, or it may exist in connection with an empyema cavity. According to etiology, bronchial fistulæ may be divided into those due to: (1) Intrapulmonary suppuration. (2) External violence.

1. *Intrapulmonary Suppuration.*—Lung abscess and bronchiectasis are the two conditions that come into consideration, the former more often than the latter. An abscess may be the result of aspiration, or it may occur in connection with streptococcus or staphylococcus pneumonia. Whether it ruptures spontaneously into the pleura, producing a pyopneumothorax, or whether it is operated on, a bronchial fistula may result. If it ruptures spontaneously, a broncho-pleural fistula usually develops, while after operation we are more apt to find a broncho-cutaneous fistula.

2. *External Violence.*—Gunshot wounds of the lungs are the most common cause of bronchial fistula due to violence. This is particularly true of injuries with shell fragments which cause laceration and destruction of lung tissue, and which may produce an infection that delays early healing.

Anatomically bronchial fistulæ may be divided into: (*a*) Broncho-pleural fistulæ; (*b*) broncho-cutaneous fistulæ.

a. Broncho-pleural Fistulæ.—The diagnosis of broncho-pleural communication is frequently made in empyema patients, especially since the introduction of Carrel-Dakin treatment. While in some cases a fistula undoubtedly exists, as evidenced by violent cough with strangulation and cyanosis, and the statement of the patient that he tastes the solution as soon as Dakin is introduced, the only evidence advanced in the majority of cases is that the patient coughs whenever Dakin solution is allowed to run into the empyema cavity. That in all these cases a real bronchial fistula exists, is questionable. In many of these patients, especially in those in whom simple cough is induced by the introduction of Dakin solution, we are probably dealing with a reflex or a superficial injury of the lung parenchyma. Such an injury may have been produced by the point of an aspirating needle, or the point of a trocar used for catheter drainage. In favor of this assumption is the simple fact that one sees only a few cases of pyopneumothorax as compared with those cases in whom a broncho-pleural fistula is diagnosed. If a bronchial communication existed, and if this communication were the result of the rupture of

* Read before the American Society for Thoracic Surgery, May 1, 1920.

an abscess, air should be found in the empyema cavity of all these cases. It is also noteworthy that one only infrequently encounters a broncho-pleural fistula when operating for chronic empyema, even in those cases in whom a fistula had previously been diagnosed.

However, if a lung abscess has ruptured into the pleura, producing a pyopneumothorax, a real broncho-pleural fistula may develop. Such a fistula often heals, but sometimes it may be responsible for the persistence of a chronic empyema cavity and under these conditions treatment is demanded.

b. Broncho-cutaneous Fistulæ.—They may exist in connection with an empyema cavity, but usually they come under treatment alone and constitute the principal condition requiring attention. They are most often due to operative interference in case of lung abscess or to a gunshot wound. The fistula may be small, or so large that the patient is able to carry on retrograde breathing through it with his mouth and nose closed. The fistula opens directly on the skin and is continuous with it.

TREATMENT.—1. *Broncho-pleural Fistulæ.*—As stated before, the diagnosis is frequently made, but not so often corroborated. In case a small communication exists in a patient with an acute empyema, no special treatment is necessary. The routine treatment applicable in that particular case of empyema is all that is required. As the empyema gets well, the fistula usually closes. Even in those cases in whom cough and cyanosis are produced by the introduction of Dakin solution, the treatment, as a rule, does not have to be discontinued. These patients will stand the treatment quite well if the solution is injected slowly and in small amounts, with the patient in a sitting position. A good-sized outlet tube or safety valve should be provided. If Carrel-Dakin treatment is not well borne, simple drainage should be used.

In empyema cases that have passed into the chronic stage, and in whom a broncho-pleural communication clinically persists, the fistula as such does not often require treatment. As a matter of fact, it is rarely found during operations for chronic empyema. In only a few instances of a large series of chronic empyema operations was a fistula demonstrated. In all these cases one does not have to operate for the fistula, but for the chronic empyema. Obliteration of the cavity by mobilization of the chest wall and the lung with decortication of the latter will bring about healing of both conditions. The fact that the lung is mobilized and able to contract and expand, makes it possible for the edges of the fistula to unite.

2. *Broncho-cutaneous Fistulæ.*—Patients with this condition come under treatment for the fistula itself. In order to get satisfactory results, it is necessary to take into consideration the etiology of the fistula, the length of time it has existed, and any special point that may have bearing on it. As long as a bronchial fistula is a safety valve for pus coming from some intrapulmonary focus, it must not be interfered with. If the

suppuration persists too long, the cause must be looked for and removed. It may be found to be a lobulated cavity or a sinus too narrow to carry off secretions properly. One must wait until the suppuration within the lung has cleared up, before considering means to close the fistula. It will be found that the fistula narrows down as the suppuration diminishes and often closes spontaneously. Cauterization of the tract may favor such a result. However, a few cases will refuse to heal after suppuration has ceased and the fistula has taken on a healthy appearance. The two common causes for this are: (*a*) The formation of a rigid ring at the mouth of the fistula, holding it firmly to the chest wall and preventing collapse and union of its walls. (*b*) Epithelialization of the entire tract. Knowing the causes of the persistence of a bronchial fistula, suggests its treatment, which is surgical. All cases should not be treated alike, however, and I shall therefore endeavor to bring out important points on the basis of six broncho-cutaneous fistulæ on whom I operated during the last year.

CASE I.—H. G. D. The patient had a large bronchial fistula below the angle of the left scapula, with infection of the surrounding tissue. Retrograde breathing was possible. There was no empyema cavity present. The fistula was probably the result of a spontaneous rupture of a lung abscess, producing a pyopneumothorax, for which he had been operated in December, 1917. He had been in a hospital sixteen months. Unsuccessful attempts to close the fistula by operation had been made, the last in December, 1918. There was slight unproductive cough and his general condition was good. On account of the extensive scarring of the chest wall with infection, and the peculiar position of the fistula, running up under the tip of the scapula, it was decided to do the operation under general ether anæsthesia and to divide it into two stages.

April 28, 1919: Operation. First stage. Excision of old scars which radiated in several directions. Skin and muscle flaps liberated. New bone formation arising from the ends of formerly resected ribs presented quite some difficulty. A portion of the fourth, fifth, sixth, and seventh ribs had to be removed. The thickened pleura and scar tissue was dissected away and the lung then mobilized. The wound was packed with gauze without inserting any sutures.

The after-treatment consisted in daily cleaning of the wound and then packing it with gauze soaked in Dakin solution. This caused a rapid débridement of all infected tissue. The granulations became bright red and epithelium began to spread from the mouth of the fistula over these granulations.

May 19, 1919: Operation. Second stage. The skin and muscle flaps were mobilized. An elliptical incision was made around the fistula, a short distance from its mouth, and the epithelium lining it then cauterized with the paquelin. A single row of catgut sutures was then inserted to close the fistula. After this a muscle flap was

laid over the suture line and fastened in place. This was followed by closure of the rest of the muscles and skin. Two small rubber drains were inserted.

A few days after operation there was a temperature rise to 103°, accompanied by cough and followed by the expectoration of a slough. The fistula reopened temporarily, discharged necrotic material for a few days, and then closed. Except for an obstinate subcutaneous infection, the convalescence was uneventful and the final result was very good.

A review of this case would seem to show that the division of the operation into two stages was well chosen on account of the infection lodged in the tissue. The temperature and the casting off of slough was due to too deep cauterization of epithelium. This is not a good procedure, as the cases done later have proved. Cauterization should be done lightly to just destroy the epithelium, but not enough to produce a slough. The temperature might also have been avoided had the secretions had free exit early. In those cases in whom a fistula is the result of an old lung abscess, it should not be sutured, but left open to allow drainage.

Case II.—J. A. C. R. This patient presented a small bronchial fistula of the lower right chest, posteriorly. A piece of the ninth rib had been resected in November, 1918, for an empyema following influenza. Drainage had been continuous, but at the time he came under observation it was very slight, and the empyema cavity had entirely healed, leaving only the bronchial fistula.

May 6, 1919: Operation. Resection of 3 inches of the eighth and ninth ribs, under local anæsthesia. The thickened pleura was excised and the lung mobilized. After cauterization of the fistula its outer opening was sutured. The muscles and skin were then closed, inserting one small rubber drain. On account of a subacute infection the fistula reopened a week later. As soon as the wound had cleaned up, adhesive plaster strapping was applied and an early closure of the fistula obtained.

Case III.—C. V. M. Patient was admitted May 1, 1919, with a large bronchial fistula of the left upper chest, anterior axillary line, just below the inferior border of the pectoralis major. His history showed that he had a Vincent's angina in November, 1918. This was followed by what was diagnosed as either a lung abscess or an empyema that had ruptured into a bronchus. On January 17, 1919, a portion of the eighth rib had been resected posteriorly, but no pus was found. On January 24, 1919, an intercostal incision had been made in the third left interspace anteriorly, and pus was evacuated. A bronchial communication was noted at that time. At the time of admission he was still discharging thick pus, which made us suspect a cavity. In order to outline this, bismuth oil mixture was injected. The patient immediately spit up much of the injected material, but a certain amount entered the cavity. The X-ray showed a narrow sinus running backward and upward into the upper part of

an empyema cavity extending downward posteriorly along the inner border of the scapula.

June 5, 1919: Operation. To establish drainage at the dependent part of the cavity, about 2 inches of the fifth, sixth, and seventh ribs were resected posteriorly to the inner side of the scapula. A thick-walled cavity was entered, containing pus and bismuth. The thickened wall was excised and the lung decorticated. One gauze strip and two rubber drains were inserted, and the muscles and skin partly closed.

The bronchial fistula anteriorly was blowing air freely. Its margins were completely excised and it was then closed with three rows of sutures, without doing any cauterization. This wound healed by primary union. There was no escape of air at any time.

The posterior wound had entirely closed on July 2, 1919, about one month after operation.

Case IV.—B. M. N. Bronchial fistula of posterior right chest. This fistula was the result of a two-stage lung abscess operation performed September, 1918. Repeated cauterizations had failed to bring about healing. His general condition was good, there was no temperature, only slight unproductive cough, and the secretion was normal in amount.

The X-ray showed a resection of part of the ninth rib with new bone formation in the shape of a ring at the site of the former operation. A tube entered the upper portion of the lower lobe.

August 19, 1919: Operation. Incision surrounding the fistula. Resection of about 3 inches of the tenth, ninth and eighth ribs under local anæsthesia. Mobilization of lung and excision of mouth of fistula. Lining of fistula lightly cauterized. No suture of the sinus was attempted on account of the danger of setting up a pneumonic process by retention. The upper and lower muscle flaps were then sutured together, turning the cut surfaces inward for attachment to the lung. A small tube drain was inserted through this muscle suture at some distance from the sinus to act as a safety valve. Skin closed.

The wound secreted considerably for a few days and then cleared up. The sutures were removed six days after operation, and on September 6, 1919, two and one-half weeks after operation, the wound was firmly healed and has remained so. At no time did any unusual amount of cough or expectoration develop.

Case V.—S. M. This patient had a large bronchial fistula of the right upper chest, just below the clavicle. It was the result of a gunshot wound received in action September 7, 1918. The history showed that he had been operated on two days after receiving his injury, and that the bullet was removed through the wound of entry. A hæmothorax developed which became infected and was drained posteriorly by rib resection. This empyema cavity closed in March, 1919, but the bronchial fistula showed no tendency to heal.

When he came under observation he had a depression of the right upper chest with a rigid opening the size of a penny in the

region of the second rib, under the middle of the clavicle. There was considerable scar tissue about the fistula. Retrograde breathing was possible. The secretion was slight in amount.

The X-ray showed a cavity of the right upper lobe. Part of the second rib was missing, the first was intact, and the third showed an area of periosteal thickening. There was no foreign body visible.

August 21, 1919: Operation. Local anæsthesia (½ per cent. novocaine). Horizontal incision along second rib, surrounding the sinus. The pectoralis muscle was bluntly dissected back, above and below, and the entire second rib then resected. The dense scar surrounding the fistula was removed and the lung mobilized for a considerable distance above and below. We then found that we were dealing with a smooth cavity in the lung, the size of a pigeon's egg. Two large bronchial openings were visible in this cavity, one above and the other below, evidently the retracted ends of the main bronchus. There were also several smaller bronchial openings. The entire cavity was very lightly cauterized with a paquelin, not paying any especial attention to the bronchi. A transverse lung suture was then done by one row of continuous chromic catgut sutures, which brought the divided ends of the bronchus into apposition, and gave a tight closure. In order to cover this suture line and to fill in the defect occasioned by the resection of the second rib, it was decided to use a muscle flap. The entire pectoralis major muscle was liberated under local anæsthesia, retaining its attachment to the humerus as a pedicle. It was then divided in the direction of its fibres and the upper half laid directly onto the lung, filling in the space between the first and third ribs. This flap was then sutured into place, and in addition sutures were placed between its upper border and the clavicular portion, and its lower border and the upper border of the lower flap. A small safety drain was inserted at some distance from the lung suture and brought out through a stab wound. The skin was closed entirely.

On the third day the patient was out of bed. There was at no time any escape of air.

On September 6, 1919, sixteen days after operation, the wound was firmly healed, the patient had no symptoms, and there was no deformity.

Case VI.—J. F. A. The patient presented an exposed area of lung with several small bronchial openings in the posterior right chest. The condition was the result of a gunshot wound received in action September 29, 1918. He was operated on five days later and again in December, 1918, January, 1919, and May, 1919.

There was considerable scarring of the chest wall due to former operations. The empyema cavity had healed.

August 27, 1919: Operation. General anæsthesia. Incision surrounding exposed area of lung with its bronchial openings. Muscles pushed back. Resection of part of tenth, ninth, eighth, and seventh ribs, which proved very difficult because a complete bony ring had formed. Intercostal tissues removed. The lung was mobilized over

a large area which was necessary to relieve tension and allow a suture of normal lung over the affected area. Some difficulty encountered. Muscles of chest wall then united over the lung and skin finally closed. Drain inserted in lower part of wound.

The convalescence was somewhat prolonged because for a while there was an escape of air and bronchial secretions. Some of the difficulty was due to the fact that we were dealing not alone with one fistula, but with an area of lung containing several openings. However, the wound healed and the final result was very good.

CONCLUSIONS

Observations made on this series of cases, and the results obtained, lead me to make the following statements:

1. Broncho-pleural fistulæ usually close spontaneously.

2. In the few cases in whom a fistula is responsible for the persistence of a chronic empyema, treatment favoring the obliteration of that cavity will result in a closure of the bronchus.

3. Broncho-cutaneous fistulæ must be carefully studied and their etiology and the present condition of the lung taken into consideration.

4. As long as the fistula acts as a safety valve for intrapulmonary suppuration, it must not be interfered with.

5. Mobilization of the lung and fistula, allowing it to recede from its fixed position, is the most important factor in bringing about closure.

6. Muscle flaps are very valuable to cover the bronchial sinus after the necessary preparation has taken place. They aid in the closure and obviate deformity.

7. Cauterization of the fistula should always be done very lightly, to simply destroy the epithelium, never so deep as to produce a slough.

8. In case the wound is clean, suture of the bronchus should be done.

9. In cases due to lung abscess, in which it is feared that closure of the bronchus may result in damming back of secretions with the danger of pneumonia, the bronchus should not be sutured, but a muscle flap simply laid over it, placing a drainage tube at some distance to act as a safety valve.

10. Whenever possible the operation should be done under local anæsthesia.

PENETRATING WAR WOUNDS OF THE CHEST

A CLINICAL STUDY OF ONE HUNDRED AND SIXTY CASES

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At the time of America's entrance into the war, surgical opinion among the French, British, Germans, and Italians regarding the treatment of penetrating thoracic wounds had only in a measure crystallized. It had been clearly demonstrated that patients with sucking thoracic wounds did not respond well to expectant treatment, and unless immediately operated upon, died, in the large percentage of cases, either from shock, hemorrhage, and traumatopnœa, or from later infectious complications. But this was perhaps the only point in the surgical treatment of thoracic wounds upon which there was general agreement. It was emphasized by some (Duval and others) that at forward hospitals acute hemorrhage was a factor which contributed toward, or was responsible for, a certain mortality, and constituted a positive operative indication. The necessity for controlling active hemorrhage was admitted, but that it occurred in actual war experience and that it therefore constituted an operative indication, was denied by others (Hartman, *et al.*), who stated that under existing war conditions patients arrived at forward hospitals either moribund, in whom no operation was justifiable, or with hemorrhage spontaneously checked. It was asserted by some (Duval and British observers) that a large foreign body—over 1 cm. in diameter—should be removed at a primary operation in both open sucking wounds and closed wounds; and for the reason (infectious complications) that the removal of foreign bodies was generally admitted to be necessary in the treatment of wounds elsewhere. There was, however, no unanimity upon this point. A number of surgeons (among them Tuffier) were of the opinion that foreign bodies were well tolerated by the lung; that therefore in closed wounds and in open sucking wounds—unless at operation they lay directly at hand—they should be left alone until some complication directly attributable to them demanded their removal. It had been observed that the tangential and other wounds associated with extensive rib fractures, even though the parietal wounds were not open, were prone to develop infectious complications under expectant treatment; and in the opinion of some should therefore be subjected to immediate operation in order to avoid these complications. Upon this point, however, there

was no general agreement. These were the larger questions which were still being discussed. Among the minor questions were those referring to the treatment of small open wounds and the method of approach and closure of thoracic wounds. The question of approach was whether this should be through the wound of entrance or exit or at a point of election. The question of closure of thoracic wounds was whether this should be complete and without drainage; partial, that is, closure of the pleura leaving the parietal wound open; or with drainage of the pleural cavity.

In regard to the less serious injuries there was quite general agreement. The through-and-through bullet wounds, if without open pneumothorax or extensive rib fractures, and the penetrating bullet and small shell wounds of similar character, were generally admitted to do well under expectant treatment and were treated medically. The more important questions still being discussed were the time and method of aspirating hæmothorax and the time and method of treating infected hæmothorax.

Evacuation Hospital No. 1, the first of the forward hospitals to be established in the American Expeditionary Forces, began its activities with a fairly definite routine in the treatment of thoracic injuries;[1] namely, to treat expectantly or medically the through-and-through bullet wounds without open pneumothorax or extensive rib fractures, and the penetrating bullet and small shell wounds of similar character; and to operate immediately or as soon as possible upon (*a*) those with open sucking pneumothorax, at the time of the primary operation removing foreign bodies, controlling hemorrhage, and suturing or resecting the lung when indicated; (*b*) those with an acute continuous hemorrhage threatening life; (*c*) those with large intrapleural or intrapulmonary foreign bodies; and (*d*) those with extensive rib fractures. The question of complete tight closure of the thoracic wound was left for the time being an open one, but primary drainage of the pleural cavity was not contemplated. With the exception of one period, this outline for the treatment of thoracic injuries was consistently carried out. During a period of activity in September, 1918—a period of great stress of work, during which there was an influx of new surgical teams inexperienced in thoracic surgery—we in part failed to carry out this routine, and erred, if of necessity we did so, on the side of conservatism. This circumstance, although unfortunate, we believe, from the standpoint of the patient, enables us to offer a comparison of results which we otherwise could not do.

What have been the results of this more or less consistent line of treatment of thoracic injuries? Is it from the standpoint of immediate results the best immediate treatment of thoracic injuries in the army zone? Should it be modified toward radicalism or conservatism under

[1] Dr. John Gibbon, of Philadelphia, then surgical consultant to Evacuation Hospital No. 1, was responsible for this routine treatment of thoracic injuries; and to his good judgment and his many helpful suggestions are largely due the results obtained in the treatment of thoracic wounds at Evacuation Hospital No. 1.

varying circumstances? Our study may throw some light upon these questions and upon the unsettled points mentioned in our introductory paragraph.

The material which forms the basis of this study includes the following:

(*a*) One hundred and nineteen cases of penetrating thoracic wounds which were entirely under our care at Evacuation Hospital No. 1.

(*b*) Twenty-two cases in which the primary operation was performed by a number of surgeons at Evacuation Hospital No. 1 during September, 1918. These cases were seen and examined on admission by one of us (Heuer) who then acted as *triage* officer. After operation they came under our care, and such secondary operations as were necessary for post-operative complications were performed by us.

(*c*) Twenty-four cases observed at Base Hospital No. 18 at a time when it functioned as an evacuation hospital. These cases were most carefully studied and are of value in comparing the results of treatment instituted early with that instituted late.

It should be emphasized that we have unusually good records of all the cases included in this report; and because of the active coöperation of internists (Pratt and Mason), röntgenologist[2] and surgeon.

For convenience in discussion we may divide the cases into two groups—(1) those not primarily operated upon, and (2) those subjected to immediate operation.

GROUP I. ONE HUNDRED AND FIFTEEN CASES NOT PRIMARILY OPERATED UPON

A summary of this group may be given as follows: Of the 115 cases there were 53 bullet wounds and 62 shell wounds; 47 were perforating with a wound of entrance and exit; 68 were penetrating with retained missiles either in the chest wall, pleura, lung, or upper abdomen. Six were small (1–2 cm.), open sucking wounds; 109 were closed wounds. Of the perforating wounds, all, with one exception, were due to bullets.

The patients arrived at Evacuation Hospital No. 1 in the majority of instances within twelve hours after their injuries; at Base Hospital No. 18 in from one to seven days after their injuries. In the evacuation hospital series a slight or moderate grade of shock was the rule on admission; but in addition to these moderate grades, profound shock was not uncommon and was observed in twenty-one cases. Eleven of these cases recovered after vigorous shock treatment; 10 cases, practically moribund on admission, died within an hour or two after their arrival. Eighteen cases entered Evacuation Hospital No. 1 with normal pulse and blood-pressure, in whom all signs of shock were absent; and this was practically true of the base hospital series.

It would require too many pages to comment at length upon the physical findings in this group of cases, and we shall therefore but men-

[2] We are indeed indebted to Dr. Ira M. Lockwood, of Lincoln, Neb., at the time röntgenologist at Evacuation Hospital No. 1, for his coöperation in the study of these cases. His painstaking localization work especially was invaluable to us.

tion some of them. *Cough, hæmoptysis,* and *dyspnœa* were extraordinarily common and would appear to occur almost invariably when the pleura and lung are penetrated. *Acute primary hemorrhage* threatening life was not seen in a single instance in this series. In the ten cases moribund on admission, hemorrhage, if that was the chief cause of the serious shock, had spontaneously ceased. As will be noted later, secondary hemorrhage occurred in two cases. *Mediastinal compression symptoms* (dyspnœa, cyanosis, tachycardia) due to a high grade of hæmothorax were noted in twelve cases; but in none were they so urgent as to require immediate aspiration for their relief. *Extensive subcutaneous emphysema* was present in twelve cases, a slight degree in many cases. *Pure hæmothorax* occurred in 94 of the 115 cases, or in 81 per cent. In thirty-eight cases the fluid level reached well above the angle of the scapula (hæmothorax large); in twenty-nine cases reached the angle of the scapula (hæmothorax moderate); in twenty-seven cases did not reach the angle of the scapula (hæmothorax small). *Hæmopneumothorax,* exclusive of seven cases subsequently developing an anaërobic infection with gas formation, was demonstrable in twelve cases. In six cases it occurred in open wounds, in six cases in closed wounds. A *pure pneumothorax* occurred in three cases. *Hemorrhagic consolidation of the lung,* not the common type occurring about the wound tract, but involving the lung at some distance from the wound, was demonstrable at autopsy in four cases; in three it involved the lung on the side of the injury; in one the lung contralateral to the injury. *Collapse of the lung,* that interesting condition emphasized especially by British observers, was seen in only one case, but may well have frequently escaped detection. *Elevation and immobility of the diaphragm* upon the side injured was observed, although its frequency, due to the difficulty of recognizing the exact position of the diaphragm in the presence of hæmothorax, cannot be accurately stated. *Pleural and pericardial friction rubs* occurred in a few cases. *Mild abdominal signs and symptoms* were rather common in the low thoracic injuries; were marked in four cases in which a board-like retracted abdomen with hiccup and vomiting strongly suggested the perforation of a hollow abdominal viscus.

The position and course of the parietal wounds may be seen in the accompanying diagrams (Figs. 1 to 4). The wounds involved almost every part of the thorax; the missiles penetrated in almost every direction. In general the wounds were small punctured wounds without extensive laceration of tissue. Only 6 of the 115 were open wounds and these could be converted into closed wounds by a pressure dressing. Only two wounds of the entire series were obviously infected at the time of admission. The incidence of *associated rib fractures* cannot be accurately stated, for the chipping of a rib so easily escapes detection. Extensive rib fractures, however, were noted in eight cases, fracture of the clavicle in one case, of the sternum in two cases, and of the scapula in five cases. In the vast majority of cases the *foreign bodies* retained

within the thorax were small (1 cm. in diameter or less). In eight cases the shell fragments measured over 1 cm., but not over 2 cm. in diameter; in seven instances machine-gun or rifle bullets were retained.

The *clinical course* in these cases was either normal for thoracic wounds or complicated by infection or hemorrhage. Dismissing the ten cases moribund on admission and dying a few hours after their arrival, 80 cases pursued a normal clinical course, 25 developed some complications with reference to their thoracic injuries.

What we may term a normal uncomplicated course may be briefly outlined. The patients, admitted in a condition of shock, often with dyspnœa, cyanosis, and anxiety, and with a varying amount of pain, cough, and bloody expectoration, present the picture of a serious injury. With complete rest in a heated bed and with morphia in adequate doses to induce quiet, the whole picture, as a rule, changes within a few hours, and, with the exception of the very seriously shocked, almost invariably by the following day. Their general appearance improves, their color returns, their pulse becomes stronger, their blood-pressure rises; dyspnœa and cyanosis become less marked; and their anxiety disappears. Cough with bloody sputum varies; it may be slight or it may be troublesome for days. Their striking change for the better is a source of astonishment, and gives rise to the impression that their previous apparently serious condition was out of all proportion to the injury or the amount of blood lost. In the seriously shocked the response to treatment is not so marked, and, as in eleven cases of this series, the condition of shock may give rise to anxiety for from twenty-four hours to three days. Fever in cases progressing normally is the rule and may vary within wide limits. In our series of cases the temperature soon after admission rose to 100° to 101°, sometimes to 103° to 104°, and showed either a continued elevation over several days or daily slight remissions. Most frequently the temperature began to decline on the third to the fifth day, but showed a daily rise to 99° to 100° for from ten days to two weeks. A relatively high fever may, however, persist for two weeks and may not completely disappear for three or four weeks. In a relatively few the temperature may be normal and remain so throughout the course. With the exception of cough, bloody sputum and fever, which are common to these injuries, no untoward symptoms appear; and within two weeks the patient's strength has returned and he is able to be up and about.

Complications.—Unlike that in many institutions in forward areas in which prompt evacuation of patients was imperative, it was our policy not to discharge patients with thoracic injuries until the danger of all complications had passed. We believe, therefore, that the complications to be enumerated represent practically the total incidence of complications in this series.

Infected Hæmothorax.—This, the most frequent complication of penetrating thoracic wounds, occurred in 18 or 17 per cent., of the 105 cases

which survived the immediate effects of their injuries. Three of the 15 cases in the base hospital series, or 20 per cent., developed this complication; 15, or 16.5 per cent., of the evacuation hospital series. The predominating infecting organisms were the gas bacillus of Welch in seven cases, the streptococcus hæmolyticus in three cases, the streptococcus viridans in one case, pyogenic staphylococci in five cases, and unknown in two cases. When we critically examine the cases which developed infected hæmothorax, we find that seven cases had neither open wounds, large retained foreign bodies (in two of these cases the size of the foreign body is not known), nor extensive fractures; in other words, did not present the conditions which we had learned predisposed to infectious complications. The remaining eleven cases, however, presented one or more of these conditions. It is interesting to note that four of the six cases with small open wounds developed infected hæmothorax; seven of the eight cases with retained shell fragments larger than 1 cm. in diameter developed this complication; as did three of the eight cases with extensive rib fractures. Eleven of the cases which developed infected hæmothorax were wounded by shell fragments which were lodged within the thorax; seven were wounded by bullets, of which six perforated the thorax and one penetrated and lodged within the thorax. While too small a series from which to draw any positive conclusions, the evidence from it supports the view that open sucking chest wounds, large retained foreign bodies, and extensive fractures of the bony thorax are conditions which favor the development of infectious complications.

The clinical course in cases developing an infected hæmothorax is usually quite different from those progressing normally. We can distinguish two groups of cases: those in which infection develops early and those in which it appears late. In the instances of early infection the temperature, which in cases progressing normally begins to fall on the third to the fifth day, fails to do so; rather it shows each day a little higher elevation or may assume a septic curve. In addition, the patient does not feel well nor look well, as in uninfected cases, but complains of thoracic pain and dyspnœa, has tachycardia, is restless, and has disturbed sleep. Such relatively benign symptoms should give rise to the suspicion of infection and warrant aspiration for cultural purposes. In the single case of streptococcus viridans infection, no more alarming symptoms developed; but the streptococcus hæmolyticus, gas bacillus, and some of the pyogenic infections were accompanied by high fever, tachycardia, signs of toxæmia, and thoracic pain. In the instances of late infection (developing from one to three weeks after the receipt of the wound) a normal course with a falling temperature was rather suddenly followed by a sharp elevation of temperature and by the symptoms and signs we have just enumerated. The physical signs in both groups may remain as before; or show an increase in the fluid level. Most striking in their symptomatology and physical signs are the infections with anaërobic organisms (Welch

bacillus), whether occurring early or late. Within twenty-four hours the patient, previously progressing normally, becomes seriously ill, with a temperature of 104°, with a pulse of 120 to 140, and with dyspnœa, cyanosis, toxæmia, and delirium. Physical examination shows a marked change due to the gas formation. A pneumohæmothorax has replaced the hæmothorax, and the intrathoracic pressure has increased, as shown by the cardiac displacement.

Pneumonia.—Pneumonia occurred in two forms—as a septic broncho-pneumonia occurring about the seat of the lesion, or as a lobular or lobar pneumonia. Obviously, it is difficult to form any accurate estimate of the frequency of pneumonia upon the side wounded; for the presence of hæmothorax, of hemorrhagic consolidation, of congestion, and of the symptoms of fever, cough and blood-stained sputum, so common in all chest wounds, makes a proper interpretation of the physical signs almost impossible. By autopsy examination pneumonia was demonstrated in seven cases, four of which were associated with infected hæmothorax. In two cases an extensive broncho-pneumonia of the usual type occurred in the lung contralateral to the injury; in two cases a widespread septic broncho-pneumonia surrounded the pulmonary wound; and in two cases a bilateral septic broncho-pneumonia was present. In only one case did we observe a pneumonia of the lobar type; and in the lung contralateral to the injury. By physical examination four other cases which recovered were considered to have had a broncho-pneumonia on the side of the injury.

Pulmonary abscess and gangrene were exceedingly rare in this series. In one case included under the cases of infected hæmothorax above, pulmonary gangrene with secondary abscess formation was recognized by the fetor of the breath and the offensive expectoration, and was confirmed by autopsy examination. In a second case a lung abscess, unsuspected clinically, was found at autopsy. The patient, with two penetrating thoracic wounds and multiple wounds of the extremities, developed gas gangrene of one leg necessitating a thigh amputation. He died with all the symptoms of gas intoxication. At autopsy a lung abscess 7 by 5 cm. was found along the wound tract in the middle lobe of the right lung, lying freely in which was a fragment of rib driven into the lung by the missile. The missile itself was embedded in the liver with no reaction about it.

Septicæmia, pyæmia, and *purulent pericarditis* occurred in association with other infectious complications of thoracic wounds in three cases.

Infection of the parietal wound, as previously noted, was observed in but two cases on admission, and in these was of no moment. The single serious infection which occurred in this series was a gas infection (Welch bacillus) which developed in a bullet wound and spread rapidly in the tissues of the thoracic and abdominal walls. In spite of the most radical incisions, the patient promptly died of gas gangrene. At autopsy there was no other cause of death.

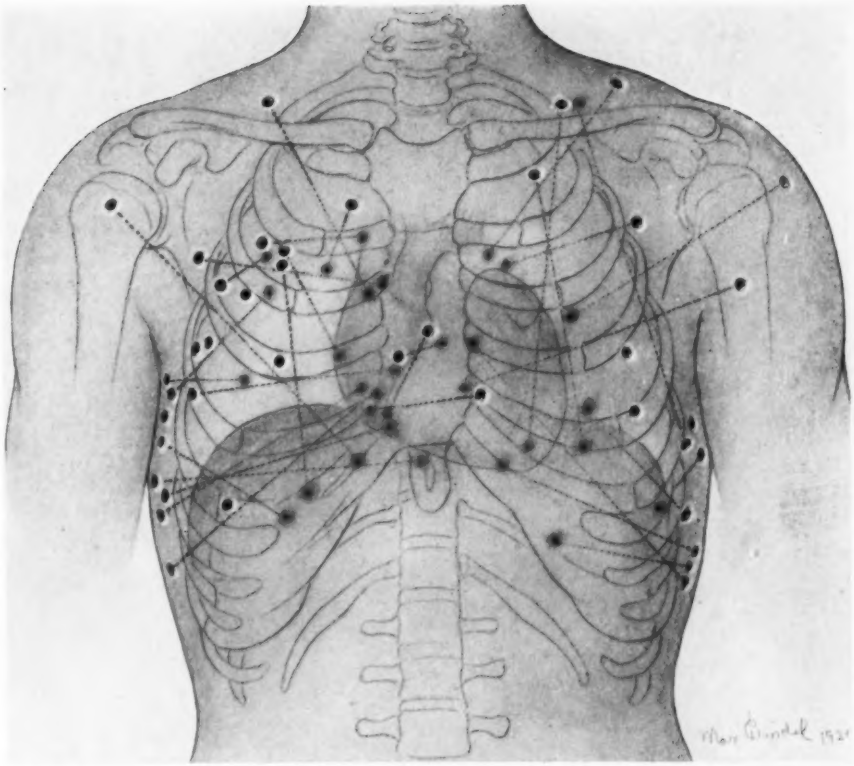

FIG. 1.—Composite picture of forty of the penetrating wounds of the ventral surface of the thorax of which we have accurate records. The wound of entrance is represented by a black dot, the course of the missile by a dotted line, and the point of lodgment of the foreign body by a shaded dot.

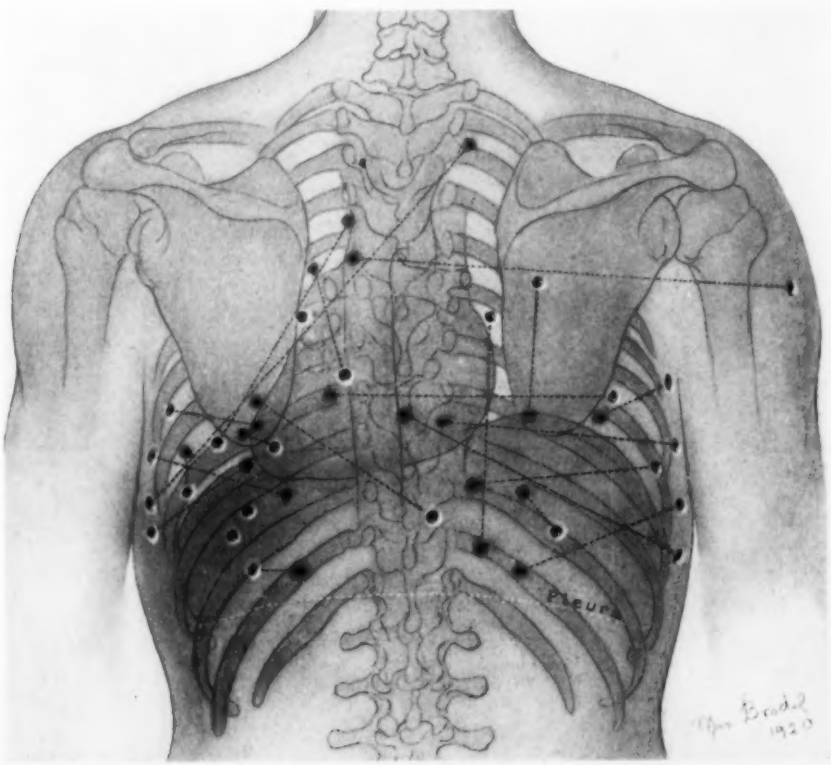

FIG. 2.—Composite picture of twenty-three of the penetrating wounds of the dorsal surface of the thorax. The same technic for representing the wound of entrance, the course of the missile, and the point of lodgment of the foreign body is used as in Fig. 1.

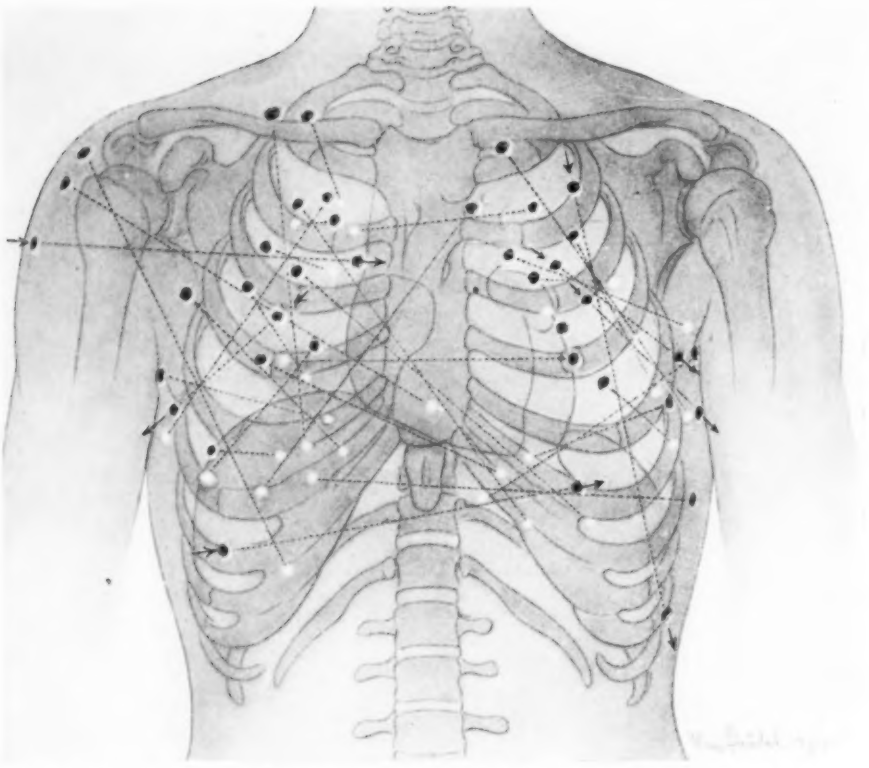

FIG. 3.—Composite picture of thirty-nine of the perforating wounds of the ventral surface of the thorax of which we have accurate records. The wound of entrance is represented by a black dot, the course of the missile by a dotted line, and the wound of exit, if upon the dorsal surface of the thorax, by a white dot. The wounds which perforated the ventral surface of the thorax alone are represented by black dots and arrows.

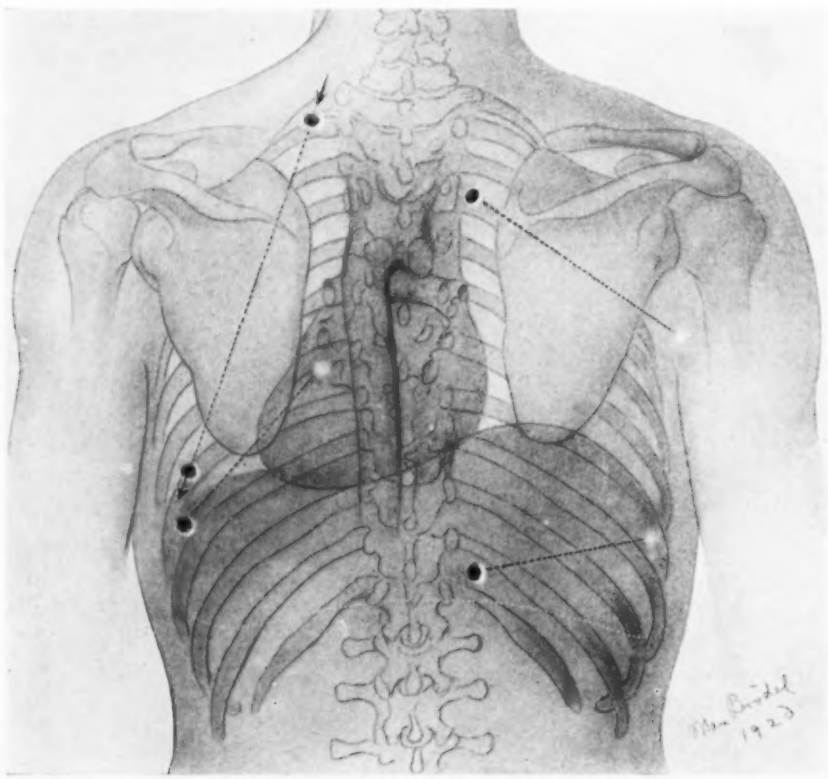

FIG. 4.—Composite picture of the perforating wounds of the dorsal surface of the body. The same technic for representing the wounds of entrance and exit is used as in Fig. 3.

Secondary or late intrapleural hemorrhage occurred in two instances. One patient was wounded by a shell fragment posteriorly, the missile traversing the right thorax obliquely and lodging under the skin just to the right of the sternal margin. For six days he pursued a normal uncomplicated course; then suddenly after violent coughing complained of weakness and went into collapse. When seen he was pallid, cold, and sweating, and had a scarcely perceptible pulse at the wrist. The signs of hæmothorax had increased. Although recognizing the hemorrhage, thoracotomy to control it was out of the question. In spite of our usual measures to combat shock the patient died. At autopsy the right thoracic cavity was completely filled with blood, and the heart markedly dislocated toward the left. An open wound of the right internal mammary artery was found and it was supposed that a clot had been dislodged from the vessel during the paroxysm of coughing. The other patient was wounded in the left supraclavicular space, the foreign body lodging in or upon the left diaphragm. In addition to a high grade of hæmothorax he had abdominal pain, marked abdominal rigidity, and hiccup. Twice in the early days of his injury he vomited blood. On the tenth day after the injury, following an effort to sit up in bed, he suddenly complained of left thoracic pain and almost immediately went into collapse. Pallor, sweating, air hunger, imperceptible pulse, and a mounting hæmothorax, all indicated a secondary hemorrhage. The day of and the day following the accident 2700 c.c. of bloody fluid were aspirated because of pressure symptoms. The cultures from the fluid, previously sterile, showed a hæmolytic streptococcus, and therefore a rib resection with drainage of the infected hæmothorax was done so soon as the patient's condition warranted it. Subsequent sterilization of the cavity by Dakin's solution was followed by secondary closure of the sinus tract.

Treatment.—The treatment in this group of cases may be briefly outlined. Absolute rest in a warm bed and morphia in sufficient doses to induce quiet were the first and important steps in the treatment. Shock was immediately and energetically treated by the usual methods. As previously noted, all our efforts in the treatment of shock were unavailing in the ten cases practically moribund on admission. In the lesser degrees of shock, blood transfusion, intravenous gum acacia (Bayliss's solution), intravenous saline, hypodermoclysis and salt and coffee per rectum, together with elevation or bandaging of the extremities were used. Our success in treating shock depended upon its degree and duration. The profoundly shocked in our experience did not respond to the various methods which we employed, excepting to blood transfusion when hemorrhage was the factor in the production of shock; nor did those who had been seriously shocked for from twelve to twenty-four hours before coming to us. It is indeed difficult in such a small series of cases to form any just estimate of the value of various measures in the treatment of this condition. Through the efforts of our " shock teams " we have accurate

records of pulse and blood-pressure determinations before and after the use of various measures; and we may summarize our experience as follows: (*a*) That marked beneficial effects follow the use of external heat, rest, and morphia in the lesser degrees of shock; (*b*) that blood transfusion is of the greatest value in those in whom hemorrhage is the factor in the production of shock. Yet we observed patients profoundly shocked in whom there was no evidence of serious hemorrhage and in whom blood transfusion had but slight, if any, effect upon the pulse or blood-pressure. In these cases Bayliss's solution failed to have any more effect. (*c*) That in profound shock of *long duration* neither Bayliss's solution nor intravenous saline, hypodermoclysis, nor salt and coffee per rectum had any appreciable effect upon the pulse or blood-pressure. In the few cases which recovered it cannot be said, however, that these measures did not have some beneficial effect. (*d*) That in the lesser degrees of shock intravenous saline or salt and coffee had about as marked an effect upon the pulse and blood-pressure as did gum acacia. Our poor results in the treatment of profound or serious shock we feel were due to the fact that the condition as we saw it at an evacuation hospital was not comparable either to the *recent* shock produced in the laboratory or to that seen in civil life following operations. It had persisted for hours and sometimes for twenty-four hours before treatment could be instituted.

The subsequent treatment of this group of cases consisted in the treatment of mediastinal compression symptoms, of hæmothorax, and of infectious complications. Mediastinal compression symptoms were treated by aspiration. In the majority of the twelve cases requiring this procedure, one aspiration of 500 to 800 c.c. sufficed; in two cases as many as three aspirations on successive days were necessary. The treatment of hæmothorax was along well-established lines. Aspiration was done for two purposes—for diagnosis and for treatment. Knowing that every thoracic wound was potentially infected, and fearing the consequences of unrecognized infected hæmothorax, a small syringeful of blood for cultural purposes was aspirated either daily or every other day in all cases which were not progressing perfectly normally. Aspiration for treatment was performed because the large collections of fluid are absorbed very slowly, and when not removed give rise to a thickened pleura and adhesions obliterating the costodiaphragmatic sulcus; conditions which impair pulmonary function and give rise to many post-traumatic subjective complaints. In the series of 105 cases, aside from the removal of small amounts of blood, aspiration of from 200 c.c. to 3000 c.c. of blood was performed in thirty cases, and chiefly in those with large collections of fluid. Two methods of aspiration were used—an early aspiration of from 200 c.c. to 500 c.c. on the fourth or fifth day, repeated if necessary on succeeding days until all the blood was removed; or a late aspiration, usually on the tenth to the twelfth day, removing at one sitting all the blood that could be obtained. A third method—early total aspiration

combined with artificial pneumothorax, used with especial success by Italian observers—was not employed by us. Of the two methods used by us, early aspiration was used in twenty cases, late aspiration in ten cases. To have used aspiration in the treatment of hæmothorax in but 30 per cent. of our cases would appear to indicate that we were not enthusiastic in its use; but this is not true. In the earlier period of our experience, we, as many others previously inexperienced in the treatment of thoracic wounds, failed to aspirate many cases which later would have been subjected to this treatment. In the large and moderate collections of fluid, aspiration is an aid in the treatment of hæmothorax, for it permits a more rapid expansion of the lung, and, when done early, probably prevents the deposition of a thick layer of fibrin upon the pleural surfaces. We have no evidence, however, that aspiration prevents the obliteration of the costodiaphragmatic angle nor the formation of adhesions between the diaphragm and costal pleura. A study of the X-rays of our cases shows that practically all cases previously having a large or moderate hæmothorax had at the time of their discharge (a month or more after their injury) adhesions obliterating the costodiaphragmatic angle; and to practically the same extent whether aspirated or not. Pleural thickening was a much less conspicuous finding; nor was retraction of the thorax very evident. If we can judge from our own series, obliteration of the costodiaphragmatic angle is the most constant and conspicuous of the abnormalities following hæmothorax.

The treatment of the eighteen cases developing infected hæmothorax consisted, with one exception, in rib resection and drainage so soon as the diagnosis was established by cultures of the aspirated fluid. We cannot see any justification for delaying operation and resorting to aspiration until a frank empyema has developed, for only too often a delay is followed by septicæmia, purulent pericarditis, pyæmia, and death. Operation was followed by sterilization of the pleural cavity by Dakin's solution; with subsequent excision and closure of the sinus so soon as the cavity was sterile. In the single exception to this form of treatment—an instance of streptococcus viridans infection—we resorted to repeated aspiration. The patient eventually recovered, but his convalescence was prolonged beyond that of those treated by rib resection, and we are certain that he would better have been treated as the others.

Of these 18 patients, 11 recovered and 7 died. An examination of the autopsy records of the 7 dead shows that in only one was death due to a simple infected hæmothorax. Four cases showed an extensive bronchopneumonia; one case, pulmonary abscess and gangrene associated with a bronchial fistula; and one case showed a healed sterile cavity, death being due to septicæmia and pyæmia, the result of a purulent knee-joint. In the cases which recovered, the cavities were sterile and closed at the time the patients left the hospital. We know the late results in only two cases, and both of these are of great interest. Due presumably to firm

adhesions preventing the expansion of the lung, the cavity persisted in one case for four months, in the other for eight months. Yet during all this time the sinus tracts, closed over the sterile cavities, remained healed and the patients suffered in no way because of the presence of their unobliterated pleural cavities. Subsequently both cavities became obliterated; and since their return to this country we have X-rays of these patients showing the complete obliteration of these long-standing cavities.

The treatment of the other infectious complications requires no further comment.

Results.—Of the 115 cases included in this group 10 were admitted in a moribund condition and died within a few hours after their arrival, untreated excepting for measures to combat shock. In the 105 cases which survived their primary injury, there were 11 deaths, 7 of which occurred in the group of cases which developed infected hæmothorax. Of the 4 other deaths, one followed hemorrhage from the internal mammary artery; one, gas infection of the thoracic wall; one, gas gangrene of the leg; and one, lobar pneumonia. In two cases death was wholly due to causes unrelated to the thoracic wounds. The total mortality in this group was, therefore, 18 per cent. If we exclude the cases moribund on admission and those dying from other injuries, the mortality in the 105 cases is 8.5 per cent. As previously noted, 80 cases pursued an uncomplicated course. These were kept in bed, as a rule, for from ten days to two weeks; were discharged in from three weeks to one month. They were comparatively free from symptoms and apparently well, and we have the feeling that few could have developed later complications. In the 11 of the 18 cases which survived infected hæmothorax, the pleural cavities were sterile and the sinus tracts closed before the patients were discharged.

Discussion.—When we review this series of cases in the light of our study, could we have improved our treatment? The group of 10 cases moribund on admission were clearly beyond our help, and if any treatment could have benefited them, it should have been and perhaps was carried out at the dressing station. With the exception of one case of fatal secondary hemorrhage, all the 11 deaths not occurring immediately from shock and open thorax were the result of infectious complications, and it is to these that we should particularly devote attention. Seven deaths followed infected hæmothorax; one death was due to an uncomplicated pneumonia, 2 to gas infection and gangrene. Granted that the surgeon is skilled in thoracic work, it would seem in the light of subsequent events that we could have done better had we excised and closed the open wounds, removed the large foreign bodies, and repaired the extensive rib fractures, for these conditions were obvious factors in the causation of infected hæmothorax. We should, in other words, have taken these cases from the non-operative group and placed them in the operative group.

GROUP II. FORTY-FIVE CASES SUBJECTED TO IMMEDIATE OPERATION

These cases include: (1) Twenty-two operated upon by a group of surgeons at Evacuation Hospital No. 1 during September, 1918; they were seen and examined by one of us (Heuer) who then acted as *triage* officer, and after operation came under our care; (2) 8 cases operated upon at Base Hospital No. 18 at a time when it functioned as an evacuation hospital; and (3) 15 cases operated upon by one of us (Heuer). Ten were bullet wounds and 35 shell wounds; 9 were perforating with a wound of entrance and exit; 36 were penetrating wounds with retained foreign bodies. Thirty-three were large open " sucking " wounds; 12 were closed wounds.[3] These figures show the preponderance of shell wounds over bullet wounds in these more serious injuries.

Time Interval.—In the evacuation hospital series the time interval between receipt of the injury and admission to the hospital varied between six and twenty-four hours, in the large majority being about twelve hours. In the base hospital series it varied from twenty-four hours to eight days.

Shock.—In the evacuation hospital series a profound degree of shock was the rule in those with open sucking chest wounds. The patients arrived pale, cold, and pulseless, with a low blood-pressure and with dyspnœa, cyanosis, and anxiety. Undoubtedly, open pneumothorax is one of the most important contributing factors in this serious grade of shock, and it was often noted that the patient's condition improved after the thoracic breach was closed. Moreover, it seemed clear that the large open wounds were associated with greater shock than the smaller wounds. In those with closed thoracic wounds, shock was a less conspicuous feature, and in at least five cases the appearance and clinical signs of shock were absent. In the base hospital series shock, with one exception, had been recovered from at the time of the patient's admission.

Cough, hæmoptysis, and *dyspnœa* were more troublesome in those with open sucking wounds than in those with closed wounds. While in the latter, cough can usually be controlled by sedatives, in the former it cannot be satisfactorily checked until the thoracic wound is closed. Dyspnœa, relatively uncommon in our series with closed wounds, was invariable in open wounds, was sometimes most distressing, and was always accompanied by a varying degree of cyanosis. It persists so long as the thorax is open, and indeed tends to become progressively worse.

Acute primary hemorrhage threatening life did not occur in those with closed wounds; was in no instance the indication which led to thoracotomy in those with open wounds. Yet upon opening the thorax in four of the cases the lung was found to be actively bleeding, the continuation of which would undoubtedly have caused a fatal termination.

[3] In the Base Hospital No. 18 series the original condition of the wounds at the time of admission is not positively stated. In the absence of a definite statement it is assumed that they were closed wounds, and are counted as such.

Character of Wounds.—With the exception of the twelve closed wounds, the character of the wounds in this group of cases was in marked contrast to those in the preceding group. They were large, varying in size from 2 to 5 cm. in diameter, and showed extensive laceration of the skin, subcutaneous tissues and muscles. In practically every case, from one to three ribs were extensively fractured, and in addition there occurred fractures of the scapula, sternum, and spinous processes of the vertebræ. Six of these extensively lacerated wounds with comminuted fractures of the bony thorax were caused by bullets, the remainder by shell fragments.

In the open wounds the retained foreign bodies varied in size from 1.5 to 3 cm. in diameter; in the closed wounds they were small.

Hæmothorax in pure form occurred in all but one of the twelve cases with closed wounds. The amount of fluid in those with open wounds varied with the position of the open wound, for the blood escapes from the wound with respiratory movements and coughing.

Abdominal signs were noted in eight cases. These consisted chiefly of upper abdominal tenderness and rigidity. In no case was there hiccup, and in only one case was vomiting noted. At operation the diaphragm was perforated or lacerated in all cases which showed abdominal signs; in one case which showed perforation of the diaphragm no abdominal signs were present.

Clinical Course.—The clinical course in this group of cases cannot be discussed, for all the cases were within a short time after their arrival subjected to operation. Yet we know from our observation of the ten cases included in Group I as moribund, and from the literature of French, British, German, and Italian observers during the early period of the war what the clinical course of these cases is when treated expectantly In those with large open wounds, shock is not recovered from, but rather becomes more profound and death occurs in the majority of cases in from twenty-four to forty-eight hours. Should life be prolonged for several days, infection invariably occurs and terminates the course. The mortality in the early period of the war was practically 100 per cent. In those with small open wounds life may be prolonged, but infection is almost certain.

Operative Treatment. (*a*) Indications. Before taking up our operative procedures let us for a moment discuss our operative indications. As noted in our introductory paragraph, our routine operative indications were open pneumothorax, large retained foreign bodies, extensive rib fractures, and acute primary hemorrhage threatening life. To these we must add our inability to positively diagnose the presence or absence of an intra-abdominal injury. When we analyze our cases these operative indications occurred as follows:

1. Open sucking thoracic wounds occurred in thirty-three of the forty-five cases (73 + per cent.), and was the urgent operative indication. In twenty-six of these cases we have records of extensive fractures of one to

three ribs combined in some instances with fractures of the scapula, sternum, and vertebral spines. In twenty-three of these cases a large foreign body was retained. In the shell wounds of the thorax, therefore, the combination of three of our operative indications presented itself in the large majority of cases (70 per cent.). Open thorax alone without extensive fractures or retained foreign bodies was the indication in two cases. Large retained foreign body alone was the operative indication in only one case. Extensive fractures alone was the indication in but two cases, but from our experience in Group I should have been the operative indication in others.

2. Acute hemorrhage threatening life was not the prime indication in any case, but as previously noted, in four of our personal cases active hemorrhage from the lung was found at operation. Active bleeding from the thoracic wall was not observed.

3. Our inability to diagnose the presence or absence of an intra-abdominal injury was the indication for thoracotomy in six cases, but in two there was the additional indication of a large retained foreign body. Had we felt sure of the absence of an abdominal injury, four of these cases might well have been treated expectantly.

Operative Procedures.—Contrary to the outline given in our routine that operation in thoracic injuries should include excision of the wounds, removal of foreign bodies, control of hemorrhage, treatment of the wounded lung when indicated, and subsequent complete closure of the thoracic wound, this complete operation, if we may so term it, was not consistently carried out. Rather, three more or less distinct procedures were carried out, and it will be of interest to compare the results obtained in each.

1. The simplest procedure employed was the excision or *débridement* of the wound of the soft parts and the removal of bone fragments. The thoracic cavity was not opened widely, the hæmothorax not evacuated, the foreign body not removed, and the lung not examined. The pleura or intercostal muscles were closed, and the skin either closed or left open. The procedure, then, consisted simply of *débridement* with closure of open wounds, or *débridement* with opening and reclosure of closed wounds. This type of procedure was employed in seven of the base hospital cases and in one of the evacuation hospital cases—eight cases in all. It is evident from the histories that these were the least seriously injured. Shock had been completely recovered from in the base hospital series and was absent in the single case in the evacuation hospital series. The wounds were small, the rib fractures not so extensive as in the more serious injuries. The results in this group of cases were as follows: Three of the eight patients died; one from presumably a valve pneumothorax, one from pulmonary gangrene, and one from lung abscess. The death from valve pneumothorax was due to faulty technic and should have been avoided. An incomplete closure of the pleura was followed by symptoms of pressure pneumothorax which were recognized too late to save the patient. At

autopsy nothing to account for death excepting a pneumothorax was found. Two additional cases which recovered developed post-operative complications. In one the wound, not completely closed at the primary operation, became infected, with the subsequent development of pyopneumothorax; in the other an infected hæmothorax developed requiring a subsequent rib resection and drainage. Fifty per cent. of these cases, therefore, developed post-operative infectious complications following incomplete operations, of which 37.5 per cent. died. It should be remembered, however, that operation in these cases was performed late—at a time when infectious complications are more prone to occur.

2. The second procedure consisted in the *débridement* of the wounds, an exploratory thoracotomy, the evacuation of the blood in the thorax, the *débridement* and suture of wounds in the lung when feasible, and the removal of foreign bodies when possible. The pleura was closed, but the overlying muscles and skin were left open because of the presumed danger of infection. This procedure was carried out in twelve cases. Six patients recovered without complications and were discharged well. Four patients developed infections in the wounds which had been left open, the infection resulting in the reopening of the pleura and the development of a pyopneumothorax. Three of these four cases died, their death being due to infection; one recovered after a secondary rib resection and drainage at a point of election. Two additional cases died within twelve hours of the operation from shock. The mortality in this group was, therefore, 41.6 per cent. Infectious complications occurred in 33.33 per cent. In contradistinction to the first group of cases these were operated upon early; that is, within eighteen hours from the receipt of their injuries. It is interesting to note that none of these cases developed pulmonary abscess or gangrene. How much a complete operation had to do with it is difficult to determine. Bone fragments embedded in the lung, if of any size, were certainly removed. Foreign bodies were removed in three cases; were not removed in five cases. In three perforating wounds foreign bodies were not present.

3. The third procedure consisted in the careful excision or *débridement* of the wound, the careful removal of all bone fragments from the pleura, the evacuation of the hæmothorax, the removal of foreign bodies and bone fragments from the lung whenever possible, the excision of the wounds in the lung when feasible, followed by suture, and the complete air-tight closure of the thoracic wound. This so-called complete operation was carried out in twenty-five cases. Twenty-one patients recovered, all but one without any complications whatever; one case developed a post-operative infected hæmothorax but recovered following a rib resection with drainage. Three cases died of shock within twelve hours of operation; one case died of a post-operative streptococcus empyema. The mortality in this group, therefore, was 16 per cent. Post-operative infectious complications occurred in 8 per cent. In this series foreign bodies were removed in

fifteen cases, not removed in three cases, and not stated in three cases. In four cases of perforating wounds no foreign bodies were present.

Discussion.—When we compare the results obtained by these three procedures the most striking dissimilarity is in the frequency of post-operative infectious complications. Following the first procedure, 50 per cent. of the cases developed such complications; following the second, 33.33 per cent.; and following the third, 8 per cent. The condition of the patient may be eliminated as a factor in these results. Shock was absent in the first group, present in equal degree in the second and third groups. The time interval is a definite factor in the results in the first group, for the operations were performed late, when infectious complications are more prone to occur. Time is not, however, a factor in the results in the second and third groups. The difference in the results appears to be due to the type of operation which was performed. In the first group the operation was totally inadequate. Lacerated wounds of the lung and large collections of blood in the presence of infected missiles and bone fragments—wound conditions which are prone to give rise to infection—were left untreated. In the second group, although a relatively small number of foreign bodies were removed, the obvious great mistake was the failure to completely close the thoracic wound. As a result the parietal wound became infected, the pleura reopened, and a pyopneumothorax developed—conditions which were responsible for all the deaths not due to shock. The third procedure as outlined above, and including the complete air-tight closure of the thoracic wound, gave by far the best results and would appear to be the operation of choice in cases requiring immediate operation. That it is adequate when carefully performed is indicated by the fact that in fifteen cases operated upon by one of us (Heuer) there was not, aside from a single stitch abscess, a single complication of any sort.

Results.—The results in this group of forty-five cases have been in part indicated above. The total mortality in the series was twelve, or 26.6 per cent. Of the thirty-three cases which survived, thirty recovered without complications, and three developed infected hæmothorax which required a secondary rib resection and drainage. In the thirty cases which recovered without complications, the immediate and presumably also the late results, were most satisfactory—much more so than in cases treated expectantly. The lung was completely expanded in ten days, pleural thickening did not occur, and adhesions fixing the diaphragm in a high position were absent. Subjective complaints of thoracic pain, dyspnœa, and tachycardia were quite uniformly absent. The results were so much better than in cases treated expectantly that one is almost tempted to suggest thoracotomy in the treatment of hæmothorax. Of the twelve cases which died, five deaths were due to shock, six to post-operative infectious complications, and one to post-operative pneumothorax.

To sum up the entire series of 160 cases: There were 127 recoveries and 33 deaths, a general mortality of 20 per cent. If we exclude the 10 cases

moribund on admission and dying untreated and the 2 deaths due to causes unrelated to their thoracic wounds, the mortality is 13 per cent. Eighty cases in the non-operative group recovered without complications; 25 developed complications, with one exception of an infectious nature. Of these 11 died. Ten patients died of shock, untreated except for measures to combat shock. Thirty cases in the operative group recovered without post-operative complications; 10 developed post-operative infectious complications, of which 7 died. Five cases died of shock within twenty-four hours after operation.

As a result of this study we may offer what evidence we have bearing upon the treatment of penetrating thoracic injuries. Our experience confirms what had already been established, that a large open thoracic wound constitutes a positive operative indication, and tends to show that the small open wound as well should be immediately closed. That the large retained foreign body is an operative indication is not so evident from our study, but it is quite apparent that it is prone to give rise to infectious complications and should, therefore, in our opinion, be removed. In the absence of all other operative indications, however, should we deliberately perform a thoracotomy in order to remove a large foreign body from the lung? Only rarely in our experience (one case in our series) will this question arise, for, as we have shown, the large foreign body is most frequently associated with open wounds and fractures of the bony thorax. In the absence of all other indications, however, the large foreign body in our experience should or should not be an operative indication, depending upon the experience and skill of the surgeon in thoracic surgery. Our experience shows that extensive rib fractures also are prone to give rise to infectious complications, and sufficiently often to warrant operation. As an isolated condition, however, extensive rib fractures are uncommon, and occur most frequently in conjunction with open wounds or large foreign bodies. Acute continued hemorrhage was never in our experience, either in the non-operative group or in the operative group, an isolated operative indication, yet in four cases operated upon because of other indications, active hemorrhage was found. Our experience, therefore, is similar to Hartmann's that in practice acute continued hemorrhage is rarely an indication, yet its possibility must always be remembered.

As a good working basis in the treatment of penetrating chest wounds we feel that the operative indications we have discussed should stand, but realizing that while stated as single indications, they rarely occur alone. When operation is indicated our experience shows that as complete an operation as the wound conditions demand, with removal of the foreign body and complete closure of the thoracic wound, is the operation of choice.

Should we be content with the medical, or non-operative, treatment of those penetrating wounds which do not present the above indications? If we exclude from our 105 cases the relatively few with small open wounds,

with large retained missiles and with extensive rib fractures, but 7 of the entire series developed infectious complications and but 5 died. When it is remembered that these results were obtained in the army zone, where the mortality from thoracic wounds is highest, we must at the present time be satisfied with this method of treatment. From the standpoint of functional end-results it leaves much to be desired, for, as we have found and as the literature indicates, retraction of the chest, thickened pleura, adherent diaphragm, and subjective complaints are common sequelæ. It is clear that operative measures prevent these sequelæ and might prevent some of the infectious complications, yet it seems certain that an added mortality due to indiscriminate operative measures would more than counterbalance the benefits derived.

From a survey of the entire literature on war wounds of the thorax, and from a study of our cases, we feel warranted in saying that the treatment which has been outlined is the best immediate treatment of thoracic injuries which has thus far been suggested. Should it be modified toward radicalism or conservatism under varying circumstances? We have no evidence to show that even under the best conditions more radical treatment would yield better results. On the other hand, our own series of cases shows the bad results of conservatism; that is, of treating expectantly those with open chest wounds, large retained foreign bodies, and extensive rib fractures. We felt compelled during one period, because of stress of work and the inexperience of surgeons in thoracic work, to include the less seriously wounded, showing these conditions among the non-operative group; with the result that our percentage of infectious complications and our mortality were greatly increased.

THORACO-ABDOMINAL INJURIES: SOME TECHNICAL PROCEDURES DEVELOPED BY THE WAR*

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Introduction.—It became a surgical axiom among chiefs of surgical teams in the A. E. F. that the mortality of war injuries was directly proportional to the multiplicity of wounds. Approximately 10 per cent. of all chest cases were associated with an injury to the diaphragm and the contents of the upper abdomen, while 12 per cent. of all abdominal cases were combined with injury to the chest or diaphragm. The right and left side were about equally proportioned and in about 10 per cent. were combined with an injury to the kidney. The lethal factor within the first twenty-four hours in the thoraco-abdominal type of wound was invariably shock or hemorrhage. In the type of case in which the abdominal lesion predominated there was in addition to the peritoneal penetration the visceral penetration with hemorrhage from liver, spleen, kidney, and mesentery, and the effusion of intestinal contents from the intestinal canal.

Every surgeon adopted a personal classification of the surgical indications for thoracotomy or for laparotomy, depending upon which injury was considered to be most likely death producing in its character. It was early recognized that combined thoraco-abdominal injuries passing from side to side through either the right or left hypochrondriac region were relatively benign—the projectile passing through both sides of the costo-phrenic sinus, traversing the liver on the right side or the spleen on the left, and producing a variable amount of damage. As the traject of the projectile approached the midline the greater the incidence of death. This fact was brought to our notice by observing that more cases arrived at the hospital dead from midline injuries than from side-to-side injuries through the hypochondriac regions. Examples of peculiar types of combined thoraco-abdominal wounds were as follows: (1) Penetrating wound involving the right lung, diaphragm, liver, and gall-bladder. (2) Penetrating wound involving the liver, stomach, and duodenum. (3) Penetrating wound involving the pericardium, diaphragm, stomach, and duodenum. (4) Penetrating wound involving left lung, diaphragm, spleen, stomach, transverse colon, and pancreas. (5) Penetrating wound involving right kidney, diaphragm, and liver. (6) Penetrating wound involving diaphragm, spleen, omentum, and pericardium.

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Anatomical Classification of Thoraco-abdominal Injuries.—Thoraco-abdominal injuries may be classified anatomically into six types. (1) The perforating wound through the costo-phrenic sinus with minimum degree of damage to diaphragm and which was characterized usually by slight, if any, visceral lesion. (2) Penetrating wound with orifice of entry high on the thorax, perforating the lung and penetrating the diaphragm with moderate or severe visceral injury. (3) A wound low down in the axillary line, usually in the seventh, eighth, or ninth intercostal space, with injury to the liver, spleen, and stomach, with gross hemorrhage into the abdomen, and rarely perforation of the colon or small intestine, and in which the entire picture was dominated by the abdominal injury. (4) A wound low down in the axillary space with considerable loss of lateral chest wall and diaphragm, resulting in herniation or prolapse of the omentum and abdominal viscera into the thoracic cavity or externally. (5) A wound in the lumbar region with injury to the kidney and associated with injury to diaphragm and abdominal viscera. (6) Tangential wounds of the chest and abdominal wall with a concussion hæmothorax and suspected chest and abdominal injury, but which upon operation proved to be superficial and without injury to either thoracic or abdominal viscera.

When the perforation in the diaphragm was of fair size or associated with gross loss of substance, herniation or prolapse of the omentum from below into the negative chamber of the chest was common, the first organ to pass through being usually the left gastro-splenic fold of the omentum. Peculiar combinations were found—omentum and spleen; stomach and spleen; stomach and transverse colon; stomach, transverse colon, and spleen. The stomach, as a rule, was only partially herniated and the herniation usually of small size.

In the group in which the abdominal injury was of major proportion the chest injury was, as a rule, of secondary or slight importance. When the injury was low down in the axillary region the lung was free from injury in more than 50 per cent. of cases.

Visceral Injuries—Liver, Spleen, and Stomach.—When the liver was injured three types of hepatic wounds were observed: (1) The tangential wound through liver substance, trench-like in character and usually with the hemorrhage arrested at the time of operation. (2) A seton with a complete clear-cut tunnel through liver substance and rarely with radiating fissures. (3) Fragmentation or pulpefaction of a lobe or portion of the liver. The initial hemorrhage from liver injuries was severe, but regardless of the type of injury it had invariably stopped at the time of operation, except when the injury was in the nature of fragmentation where the hemorrhage was continuous in type and uniformly fatal.

The search for foreign bodies in the substance of the liver was comparatively easy and they were usually located at the end of the traject or lying free in the neighborhood. Pulpefaction or fragmentation of liver substance when it occurred involved the right lobe in over 90 per cent. of

cases. The projectile in this type was, as a rule, a large shell fragment and the resulting hemorrhage progressive and continuous. The same injury on the left side brought about the same type of injury to the spleen as to the liver, with the general exception that most splenic injuries were associated with continuous and persistent hemorrhage and a much greater tendency to fragmentation. As an example of a very extensive injury inflicted on the left side by a comparatively small foreign body the following is reported: A penetrating wound due to small shell fragment, orifice of entry the left chest in the eighth interspace, in the midaxillary line, penetration of the diaphragm, tunnelling of the spleen, lateral laceration of the stomach, the projectile continuing its course through both sides of the transverse colon and lodging in the head of the pancreas. The man died at the end of twenty-four hours from suppurative, gangrenous pancreatitis.

Mortality.—The mortality in the forward area from abdominal injuries was approximately 50 per cent.; from chest injuries with extensive operative procedures approximately 50 per cent.; from thoraco-abdominal injuries usually 60 per cent., but not infrequently 75 per cent.

Technical Procedures.—It is interesting to note that in our earlier work injuries to the diaphragm were repaired through the abdomen and it was only when chest surgery was established upon a rational technic that it was found easier to repair the diaphragm through a thoracotomy than by way of the abdomen.

It was during the development of chest surgery that it was found technically satisfactory to repair the diaphragmatic wound by way of the thorax, and furthermore it was determined that quite a large tear or rent or loss of substance of the diaphragm, with protrusion of the abdominal viscera and omentum, could be easily sutured or the diaphragm approximated to the lateral margin of the chest wall. The one essential to either thoracic or abdominal technic was that the diaphragmatic injury should be sutured, for if left unrepaired death was the inevitable consequence irrespective as to the degree of abdominal injury.

The operative approach varied with the type of injury and its location. The mechanical factors involved were in brief:

(*a*) Injuries to diaphragm only—usually in costo-phrenic sinus.

(*b*) Injuries involving penetration of diaphragm with damage to subjacent viscera and with or without gross loss of diaphragm substance.

It followed logically that to either of the above there was added a technical repair of chest and lung injury, of any renal lesions or a preliminary or secondary laparotomy according to the anatomical findings. When adequate exposure of the diaphragm could be obtained by enlarging either the orifice of entry or exit the operative procedures were carried out through the wound. If the wound was not in a suitable position six to eight inches of the sixth or seventh, rarely the eighth, right rib were resected subperiosteally, the rib space spread by a rib spreader, the

pleural cavity carefully cleansed of all blood and temporary packing off of pleural cavity by pads instituted.

The repair of injuries to the diaphragm was immediately carried out or the diaphragmatic injury was enlarged so as to deal with intra-abdominal complications. There were obviously well-defined limits to the amount of work that could be performed upon the viscera of the upper abdomen, for with reduction of herniated viscera and repair of injuries to the liver, spleen, portions of the cardiac end of the stomach and occasionally the colon, very little further operative manipulation could be carried out. For injuries lower down in the abdomen it was necessary to supplement the thoracic technic with a laparotomy to deal specifically with the abdominal condition.

The suturing of the diaphragm was a matter of comparative simplicity, and after the first suture was tied it was utilized as a traction suture and the remaining portion of the diaphragm was readily sutured with a lock-stitch of No. 2 chromic catgut.

In the type of injury involving the seventh to the ninth rib in the axillary line there was usually a loss of the marginal portion of the diaphragm, and it was relatively easy to suture the parietal portion of the diaphragm to the parietal pleura and so hermetically seal off the chest leaving the wound entirely beneath the diaphragmatico-pleural suture the diaphragm to the parietal pleura, and so hermetically seal off the chest, wall—the so-called method of De Page—was not, however, carried out unless the parietal attachment of the diaphragm was torn away from the chest wall. We had recourse to this method a number of times, and it is surprising how readily the level of the diaphragm can be elevated and applied to a relatively high location on the chest wall. We never had occasion to do pneumopexy either to fix the lung or to be used as a secondary means of closing a diaphragm or chest-wall defect.

The two cases of pericardial injury were repaired through enlarging the orifice of entry in the first patient and by major thoracotomy through the seventh interspace in the second patient.

If the wound of the chest involved the midportion of the axillary space in an oblique manner it almost uniformly injured the lung and perforated the diaphragm with injury to the abdominal viscera. In this type of injury an intercostal thoracotomy was done from the midscapular line to the mammary line with removal of six inches or more of the seventh rib. By enlarging the rib space with a rib spreader it was comparatively easy to reduce herniated viscera or to enlarge the diaphragm aperture and eviscerate portions of stomach, colon, omentum, small intestines and spleen into the chest cavity for inspection or repair. In one case a splenectomy was performed through the thoracic cavity. Likewise through this incision the lower portion of the lung could be delivered and such necessary surgical procedures as were indicated carried out. In every case the laceration and traject in the lung was cleansed

and closed. The mechanical cleansing of the traject was ofttimes incomplete, but it was early established that the lung tissue itself, by reason of its peculiar vascularity, was quite able to take care of a considerable degree of infection. As evidence pointing to this contention one recalls the extreme rarity of gas gangrene of the lung tissue itself. The handling of the lung was not associated with marked fall in blood-pressure, and was not associated with the same degree of shock as would be induced by similar manipulations of the intestines. When the injury was low on the chest wall with compound, comminuted fracture of the sixth, seventh, or eighth rib in the axillary space, or if the wound was of a type known as " cave-in " or " stove-in " chest, the entire wound was enlarged, the soft tissues débrided and both ends of the fractured ribs resected, and by separating the edges of the entire wound the injury to the diaphragm was readily repaired. In these cases an element of greater importance than the injury itself was the innumerable indriven bone particles scattered through lung and diaphragm, occasionally penetrating the diaphragm and being imbedded in the liver or omentum.

In liver wounds involving the superior surface or where the projectile injured the liver laterally through the costo-phrenic sinus, the traject was swabbed out, lightly débrided and cleansed with a Volkmann spoon. Trench wounds accessible to suture were occasionally coapted or omentum sutured into the gap and once the round ligament of the liver was so utilized. In wounds characterized by fragmentation of the liver the thoracotomy was supplemented by a laparotomy for the purpose of mass gauze packing in the attempt to arrest hemorrhage.

In injuries to the diaphragm and associated with a wounded kidney it was an invariable rule to do the posterior surgery first, as it was soon discovered that to do a thoracotomy or laparotomy and then turn the patient over upon the abdomen carried with it a greater shock-producing element and mortality than the same procedures carried out in the reverse order. It was also an invariable rule to catheterize all suspected kidney injuries or to have the patient void on the table, for it was not an infrequent occurrence to be quite surprised at finding a bloody urine from a patient which from the location of the wound could hardly be suspected of having a kidney injury.

The wounds to the kidney with diaphragmatic injury were, as a rule, clean-cut tunnels through the upper pole of the kidney, and only once did we see complete fragmentation of the upper half of the kidney. We lost one case eleven days post-operatively from secondary hemorrhage due to a lateral tear in the vena cava. In one case the injury to the chest was discovered quite accidentally during an exploratory operation on the kidney, when in the course of débridement of the wound of entry there was an insucking of air. A single suture applied to the costo-phrenic sinus closed this orifice and the case was practically considered as one without injury to the chest.

A rather surprising example of a foreign body passing through the abdomen without any injury to the viscera was as follows: A gunshot wound perforating the right costo-phrenic sinus, the right kidney, entering the abdomen, passing to the external side of the ascending colon and imbedding itself in the peritoneum on the anterior abdominal wall. After débriding the kidney wound and introducing a drain down to the kidney traject a laparotomy was performed and foreign body removed. Complete exploration of the abdomen revealed absolutely no injury to the abdominal viscera. Patient made an uneventful recovery.

A critical review of thoraco-abdominal injuries and the surgical procedures adopted to deal with them, together with the immense collective experience derived from battle surgery, would seem to suggest a wider technical application of major thoracotomy to deal with lesions involving the diaphragm and the viscera immediately subjacent to it.

One of the surprising features in connection with thoraco-abdominal surgery was the facility with which the diaphragm could be elevated and sutured and the comparative ease with which the parietal diaphragm could be approximated to the parietal pleura even after great loss of substance.

It would seem that these experiences in thoraco-abdominal injuries point the way to a better technical consideration of diaphragmatic hernia, for with positive pulmonary anæsthesia and distention of the lung it should not be dangerous to do a major thoracotomy in the seventh or eighth interspace and approach the reduction of a diaphragmatic hernia from within the chest and by suture of the diaphragmatic hiatus from the thoracic side accomplish a much better technical result. Lesions of the liver, superior cardiac portion of the stomach and some spleen lesions might offer a wider application for transthoracic laparotomy with better results than are now obtained by any classical methods of approach through the abdomen.

The treatment of heart wounds through a transpleural exposure and by means of an intercostal incision under differential pressure anæsthesia offers a quick, technical exposure with ample room and obviates the dangers of pneumothorax and would seem to indicate a better technic than any type of extrapleural operation.

TRANSACTIONS
OF THE
NEW YORK SURGICAL SOCIETY

Stated Meeting held March 10, 1920

The President, Dr. William A. Downes, in the Chair

TUBERCULOUS TENOSYNOVITIS

Dr. Willy Meyer presented a man twenty-seven years of age, who came under his care two years ago, March, 1918. He was a strong young man who complained of stiffness in his left hand which had lasted for some time and inability to lift heavy objects. On examination, there was the picture of involvement of the extensor sheaths of the forearm. A large swelling covered more or less the radial aspect of the forearm. One could feel small rice-like corpuscles in the tendon sheath. The patient was advised to have the tuberculous tissue totally extirpated, leaving no focus of diseased tissue. Doctor Meyer stated that he had had a few such tuberculous tendon cases and had learned that the entire tuberculous mass must be removed in order to effect a permanent cure. At operation he was successful in removing the entire mass from tendon to tendon completely in one piece thus leaving the bare tendons exposed. The wound was wiped with a 5 per cent. iodoform ether solution, thus combining antiseptic with aseptic surgery, and the wound was completely closed without drainage, with a few silkworm-gut sutures. Rubber tissue was used to cover the line of the incision, and the dressing and splint applied.

The patient had a high temperature at first which soon came down. The dressing was left on for two weeks when primary union was found. To-day the man had an absolutely perfect functional result and was in good health. To show the rapid return of good function, it might be mentioned that the operation was performed on May 18, 1918, and in October of the same year he entered military service in the Coast Artillery, having free use of his arm and hand.

DUODENAL FISTULA AFTER CHOLECYSTECTOMY, CLOSED BY THE MEANS OF INTESTINAL FEEDING

Dr. Willy Meyer presented a man fifty years of age who came under his care for recurrent attacks of cholecystitis. On the Medical Division he had just passed through a severe acute attack. On May 26, 1919, Doctor Meyer performed a cholecystectomy by Perthes' incision, which was lengthened up to the xiphoid. The operation was technically difficult because of firm adhesions around the gall-bladder and appendix in a rather stout man. On trying to separate the peritoneal cover from the gall-bladder, as usually

done, he found that all the layers of the gall-bladder wall formed a firm unit. It, therefore, became necessary to shell out the bladder from the liver. In doing this a portion of the liver tissue came off with the bladder. The result was a very alarming venous hemorrhage, which evidently came from a branch of the portal vein. Three gauze tampons with prolonged firm compression were required to control the bleeding.

Following the operation, the patient was put to bed in the Sims's posture for twenty-four hours, as he usually did after cholecystectomy. Having done the operation just before the association meetings, the removal of the tampons had to be left to the assistants; he feared that it was done piecemeal. Soon after the removal of the tampons, it was noticed that bile came from the fistula, and at times a considerable amount of tissue was discharged. Doctor Meyer said he saw the man again in October, when he had gained twenty pounds, but he still had the fistula, from which at times a large amount of fluid escaped, which, however, had not macerated his skin. Examination of stomach and duodenal contents with the Finhorn tube proved the discharge to come, not from the upper, but from the lower part of the duodenum. Radiographs corroborated this conclusion. Having had one case in which after a secondary operation on the bile ducts a duodenal fistula was cured by feeding through a long tube, a long intestinal tube was introduced in this case. The tip of the tube soon slipped into the jejunum, where the X-ray showed the metal tip near the left anterior superior spine. Of course, no food was allowed by mouth. Improvement was soon noticed. There was a temporary discharge off and on, but on December 4th the fistula was closed. At about the middle of the same month a piece of a gauze tampon was passed through the rectum.

In connection with this case, Doctor Meyer said there were a few points of interest. One of these was with reference to the systematic examination of the duodenal contents. This had been done in addition to radiography in every case of suspected gall-bladder disease in the course of the last four to six years, making a chemical, microscopical and bacteriological examination. The X-ray had shown positive results in gall-stones in about 15 to 20 per cent. of the cases. In cases of cholecystitis without stones they were of no assistance in establishing the diagnosis. Here examination of the duodenal contents was of very great value; in fact, it was the best diagnostic means we had at present. The finding of turbid green-brown bile determined where the incision should be made, namely, on the gall-bladder. If aspiration during operation showed the same condition of the bile, cholecystectomy was done. This bile would quite frequently be reported to be sterile, but clinically the patients got well. Bacteria were often found in the gall-bladder wall on tissue culture.

What was the color of healthy bile in a healthy gall-bladder? If surgeons could get the permission to aspirate the bile from normal gall-bladders, a relation between the presence of black-green bile and gall-bladder disease

could soon be established. At the present time we did not know much about the contents of the gall-bladder in the normal living person. He believed, however, that green bile, or green-brown turbid bile, in the presence of positive clinical symptoms was an indication for the extirpation of the gall-bladder. Physiologists taught that normal bile was golden-yellow in the hepatic duct as well as in the gall-bladder.

Doctor Meyer stated that he had seen five cases in which the gall-bladder was tightly adherent to the duodenum, and when the gall-bladder was extirpated a hole was found in the latter. In several cases there was a combination of gall-bladder disease and duodenal ulcer. Where the gall-bladder was tightly adherent to the duodenum, great care should be exercised at operation in stripping it off. It was wise rather to leave a patch of gall-bladder attached to the duodenum. Nature, in cases of need, made the gall-bladder wall secure a threatening perforation of a duodenal ulcer.

Dr. George Woolsey referred to the color of the bile and its bacterial content. He was inclined to agree with Doctor Meyer that the color of the bile was dark in cases of cholecystitis, and, as the bile was commonly sterile, the bacteriological examination of the duodenal contents did not give any help in diagnosis. Doctor Woolsey asked if he had taken a culture from the wall of the gall-bladder, as it was often possible to get a positive culture from the wall and not from the contents. In regard to these fistulæ connected with the stomach and duodenum, Doctor Woolsey said recently he had removed the gall-bladder, which was very adherent to the stomach a little proximal to the pylorus, and in so doing a small opening was left through the peritoneal coat, the beginning of a perforation of the stomach. Around this opening the peritoneal coat was dissected up, and according to this, there was a ring of yellowish color about the size of a quarter, due to the action of bile. The muscular and mucous coats had not yet been perforated. A large tumor mass, readily seen and felt before operation, proved to be an abscess filling the lesser peritoneal sac with over a litre of pus. The infection was supposed to have come from the commencing perforation of the stomach. It was opened and drained and a good result obtained.

Dr. Ellsworth Eliot, Jr., said that in one patient in whom he dissected the gall-bladder from the duodenum he found no ulcer in the duodenum, but a small orifice, evidently an ulcer in the gall-bladder, which had perforated through. He closed it with a purse-string suture without further difficulty and no duodenal fistula followed.

Dr. Downes suggested that, in a case where the gall-bladder was adherent to the liver, it would be a better plan to deliberately open and empty the gall-bladder, then dissect the mucous membrane out, leaving the peritoneal and muscular coats at the adherent point. With proper precautions there was little or no danger from infection. It was worth while to take this chance in order to avoid these severe hemorrhages.

Doctor Meyer, in closing the discussion, said one of the points he wanted

to bring out was the necessity of making an examination of the duodenal contents previous to operation, and that the facilities for making such an examination should be a laboratory necessity.

In regard to Doctor Woolsey's remarks, the laboratory had reported, not in every case but in quite a number, in fact, in the majority of cases, a sterile bile. He had asked himself whether perhaps some chemical condition might be responsible for the inflammation without presence of micro-organisms. He thought that not much was known about it. It certainly was necessary to let the laboratory make the microscopic examination of the gall-bladder wall, and they had begun doing this at the Lenox Hill Hospital. The pathological report, so far as the gall-bladder itself was concerned, was always chronic cystitis. If surgeons would tap the normal gall-bladder and examine the contents, he thought much more could be learned. This might be done by penetrating the wall obliquely with a very fine needle. Perhaps patients might be willing to consent, if told that it was for the purpose of gathering information.

Regarding the gall-bladder attachment, Doctor Meyer said he was very careful in stripping the gall-bladder from the duodenum. In one of these cases he left a patch of the serous cover of the gall-bladder attached to the duodenum. He felt that asepsis was better safeguarded if one left the gall-bladder closed than by opening it. He always tried to take the gall-bladder out without opening its cavity and to find its point of cleavage between peritoneal and muscular cover of the wall of the viscus. In the case presented, the layers had formed a firm unit.

GANGRENE OF RETROCÆCAL APPENDIX

Dr. Willy Meyer presented a patient who came under his care with all the signs of acute appendicitis. When he opened the abdomen, he met a gangrenous area representing the base of the appendix, but there seemed no possibility of reaching the tip of the appendix, which was retrocæcal and thoroughly adherent. According to his experience, it was best in many of these cases, particularly of acute appendicitis, to give up working from the anterior incision and add a second one parallel to the crista ilii, commencing at the anterior superior spine; for it was here often of importance not only to feel but also to see. A short retrocæcal appendix could be gotten out best through the intramuscular incision. Sometimes it could also be developed through the para-rectus. But a long and adherent retrocæcal appendix needed an additional cut. In the case presented, the gangrenous organ was fully six inches long and had a peri-appendicular abscess at its tip, near the lower pole of the kidney. The patient made a quick and uninterrupted recovery.

CONICAL STUMP IN THE LEG

Dr. Ellsworth Eliot, Jr., presented a lad, aged sixteen years, who was first admitted to the Presbyterian Hospital when he was four or five years old, at which time he was under the care of Doctor Woolsey for

gangrene of the leg of embolic origin following diphtheria. Doctor Woolsey amputated the leg at about the middle third. The patient for a time was without material discomfort, walking on an artificial leg. Later he suffered from pain, especially while walking. Eventually a conical stump developed. The divided end of both the tibia and fibula pressed against the scar. These were removed after exposure by incision through and deflection of the cicatrix. Recovery was uneventful.

At the present time, three years after operation for the conical stump, examination of the stump showed it to be in excellent condition. There was ample flap material. At one point there was a slight exostosis on the divided tibia which did not interfere with his wearing an artificial leg. This condition, Doctor Eliot said, was much more common after amputation of the humerus than after amputation of the leg, where not only one, but occasionally several amputations were required for persistent recurrence. The fact that the growth of the upper extremity depended chiefly upon the upper epiphysis of the humerus while that of the lower depended upon the epiphyses about the knee accounted for the occurrence of this condition after amputation through the arm and leg, respectively.

SUBPHRENIC ABSCESS

Doctor Eliot presented a man, thirty-three years of age, who had always been in excellent health until three weeks before admission to the hospital. At that time the invasion was marked by sudden severe pain in the right upper quadrant, which came on while he was working. He had repeated attacks of vomiting and pain, which was severe and sharp in character and was increased by moving the body from side to side. Respiration was somewhat difficult, and his discomfort was somewhat intensified by elevating his head from the pillow. The pain radiated to the right lumbar region and to the scapula. These attacks were repeated at intervals of three or four days for about three weeks. During this time the patient lost twenty-eight pounds. When he was examined, marked tenderness was found over the right costal arch, and an indefinite sense of a mass which prevented palpation of the under segment of the arch. Bimanual examination gave the same sense of resistance, and the right costal arch could not be compressed during respiration. There was no evidence of other peritoneal irritation.

The man was operated upon on September 19, 1919. The peritoneal cavity was opened through an oblique incision parallel to the costal arch. The gall-bladder was found to be covered with adherent omentum extending over the adjacent surface of the liver. On separation of these adhesions, an abscess cavity was found to the outer side of the gall-bladder, occupying the space between the convex surface of the liver and the adjacent costal segment. The pus was not brown in color, and no orifice leading into the gall-bladder or liver was found. The gall-bladder was liberated from adhesions. Nothing abnormal was found about the duodenum or pylorus. There was no evidence of necrosis of costal cartilage. The abscess cavity

was so placed that an opening between the overlying costal cartilages for drainage was tempting, but the interval was so narrow that it was thought better to insert the rubber tissue cigarette drain through the abdominal incision, passing first into the peritoneal cavity and then at right angles into the abscess cavity. The remainder of the incision was closed in the usual way. Notwithstanding the irregularity of the drainage tract, the patient was discharged from the hospital four weeks after operation with a superficial sinus which soon completely closed. The fact that it healed promptly and remained healed seemed to indicate the absence of any erosion or lesion in the costal joint. In general, in lesions of this kind, a sinus remained for six months or a year. Doctor Eliot said he recalled one case in which the cavity did not close for eighteen months.

The origin of the abscess cavity was difficult to state. It did not come from the gall-bladder, the liver, or from any part of the intestine. The contents of the abscess consisted in ordinary odorless pus containing streptococcus hæmolyticus aureus. Doctor Eliot said he could account for it only as an abscess of hæmatogenous origin.

CANCER OF THE THYROID

Doctor Eliot presented a woman, thirty-two years of age, who was admitted to the hospital in December, 1916, complaining of a lump in her neck of three years' duration and of gradual growth. This constituted her sole complaint until five months before admission, when she noticed dyspnœa on walking. There was a swelling on the right side of the thyroid the size of a hen's egg. It was firm, smooth, and free from nodules. It showed the normal mobility associated with ordinary goitre. No one would have considered it anything else than some form of simple, benign goitre. A circular incision was made, and there was no difficulty in enucleating and resecting the right half of the thyroid. There were no signs of adhesion nor of infiltration. Ligation at the isthmus was done with chromic gut. The growth seemed to be of the colloid variety. The wound healed promptly without incident. In a few places there were some relatively normal acini, but the major portion of the specimen was a dense mass resembling thyroid acini packed closely. The large mass seemed to be formed of certain lobulations. The stroma was compressed, and in some places the cells were invaded and broken through; necrosis was taking place in some of the masses, and there were several mitotic figures. The diagnosis was carcinoma of the thyroid. Doctor Parsons and Dr. W. C. Clarke made the diagnosis. The symptoms in this case were entirely different from those of malignancy. The fact that one-half of the gland only was sacrificed was contrary to what was taught in the treatment of carcinoma of the thyroid, namely, that the whole thyroid should be removed and myxœdema prevented by the administration of thyroid extract. The thyroid was like most other parts of the body in that it was subject to slowly progressive, as well as rapidly developing, varieties of carcinoma, and in these growths operation was not

only indicated but gave very satisfactory results. In one case operated on by Doctor Erdmann the presence of glandular metastases on both sides served to make an unfavorable prognosis, yet several years after the removal of the thyroid and glands the patient was still alive and well.

Dr. Frederic Kammerer said that Doctor Eliot's case of cancer of the thyroid must have been a very early case. He had had one case of cancer of the thyroid nine years after the first operation, which was done by Kocher. In Doctor Eliot's case the cancer was very slightly developed, and was operated upon sufficiently early to get an apparently permanent cure. All surgeons, he thought, were agreed that only early operation gave a chance of success; in other words, cases in which the clinical diagnosis of cancer was not made, but the malignancy discovered only on microscopical examination. He was unable to account for the good result in the case mentioned this evening, in which metastases were found in the lymph-glands.

Doctor Eliot said that this case was of three years' standing. The carcinoma, however, was of recent formation; it certainly was not of three years' standing. It must have begun, perhaps, six months before operation. The speaker cited a case of extensive carcinoma in a woman of fifty, which developed in a goitre of at least twenty years' standing. In this instance the amount of malignancy was shown both by the development of anæmia and by adhesions to the skin of different parts of the greatly enlarged thyroid gland. In the case reported this evening there was nothing of that kind before or after the operation. If the carcinoma was not of recent growth, it had at least not gone through the capsule nor were there any enlarged glands.

Dr. Alexis V. Moschcowitz said that he had had a few cases of carcinoma of the thyroid, and they were of two classes: those in which the diagnosis of carcinoma was made before operation, and those in which carcinoma was accidentally found. In those in which the carcinoma was accidentally found the prognosis was good, while in those diagnosed as carcinoma the prognosis was bad. In other words, early cases only give a good prognosis.

CANCER OF THE RECTUM

Doctor Eliot presented a woman, forty-one years of age, who was admitted to the Presbyterian Hospital three years ago with a history of pain and bleeding from the bowels for three months and constipation for a good many years. Lately the discharge from the rectum had been very foul. The patient had been losing in weight. Examination showed a cauliflower mass of the anterior wall of the rectum at the right side. The finger passing through the lumen of the bowel could not reach the upper limit of the growth. On vaginal examination the growth was found to be movable on the vaginal wall. The case seemed to be favorable for operation, and on October 16, 1916, a colostomy was done, using the intramuscular incision, and the intestine brought out through the incision with a glass rod through the mesocolon. After this had been open several days the rectal mass was

removed by the Kraske route. The peritoneum was sewn around the margin of the rectum, which was then unfolded, leaving a smooth surface. Following the operation there was a small sinus, which still persisted, though not connecting with the bowel. The condition of the artificial anus, Doctor Eliot said, was interesting, as both the proximal and distal ends are visible and show no indication of inflammation.

Doctor Eliot said a point to which he wished to call attention was that the prolapsed sigmoid caused no obstruction, and that there was no need of an immediate opening of the bowel. Sometimes, if delayed for a week, the artificial anus would establish itself. Another point was that he thought the intramuscular incision restricted the degree of rupture or hernia. Of still greater interest was the fact that after such an incision the patient might have complete, or if not complete, at least excellent, control of the bowels. The patient with an artificial anus through an intramuscular incision was much better off than with one made through a vertical incision. The woman had three movements during the course of the day and had five or ten minutes' warning. She was capable of doing her household work and was happy and contented. An artificial anus was therefore not incompatible with the comforts of life, and patients should not be allowed to become discouraged by the prospects of such an abnormal opening when the radical removal of the sphincter ani was necessary.

Dr. William C. Lusk said that he had previously shown before the Surgical Society two cases of controllable artificial anus. In the construction of this type of artificial anus, the opening for the exit of the bowel through the abdominal wall was made in a transverse line opposite the left anterior superior iliac spine, the incision splitting part way the fibres of the internal oblique and transversalis muscles and cutting through the linea semilunaris well into the rectus sheath to prevent constriction of the gut, avoiding the deep epigastric vessels. A second transverse incision, going through the skin and superficial fascia only, was made one inch above the first, and the bridge of skin and fat between the two incisions raised from the surface of the external oblique. The peritoneum of the lower wound was tacked above and below to the outer surface of the external oblique, and the proximal extremity of the severed, liberated sigmoid, was drawn out of the peritoneal cavity through the opening prepared for its exit, turned upward over the external oblique muscle beneath the bridge of skin and brought out upon the skin surface through the higher incision, the bowel being so disposed, both in the iliac fossa as well as throughout its course of exit, that its mesenteric border always looked inward. Thus the terminal portion of the bowel occupied a position such that, with pressure applied over it externally, it would be compressed against the external oblique muscle. In the first of the cases mentioned, the orifice of the artificial anus accidentally became very small, yet with mucous membrane lining it. In the second case, the bowel end was primarily inverted and sutured tight, and later an opening of small size was made into it, which technic was made possible

through the preliminary construction of what the speaker called a "left subcostal colonic vent," which was a tube-sinus entering the descending colon just below the extremity of the left eleventh rib, serving for the prevention of intestinal obstruction and for the introduction of water, following the abdominal portion of the two-stage operation for removal of rectal cancer. In both of these cases, by the use of a flat plate compressing the artificial anus through the agency of a spring truss, continence for both fæces and wind had been attained.

Doctor Eliot said the method Doctor Lusk described had been tried, but was not always attended with success. There were one or two conditions in which it was not available. The first of these was where there was a short cæcum, so that one could not get the cæcum to take a rectangular course, and there might be some objection on account of the possibility of subsequent stricture. He had seen the procedure employed where one, two or three years later they had had to resort to the vertical incision. In these cases, provided one got good control, he thought it desirable to have a good-sized orifice, for if one had a small orifice there was danger of a secondary stricture.

Dr. Frederic Kammerer said that for the establishment of artificial ani he had always made the intramuscular incision. He had never known any stricture to follow the use of this incision if primary union was obtained. He always used the glass rod and opened the bowel forty-eight hours after it had been brought out. As to the results obtained, some of his patients seemed to have little trouble, others were very much annoyed by the involuntary passage of fecal matter. A good plan, in his opinion, was to cleanse the large intestine by an irrigation of the bowels through the colostomy opening every evening before retiring. He had seen one of the cases in which Doctor Lusk had followed the procedure he described, and the result was a very good one.

CIRRHOSIS OF THE LIVER

Doctor Eliot presented a man who was first under observation in the Presbyterian Hospital twenty years ago, having come to the dispensary. He had an effusion in both pleural cavities and a moderate effusion of the pericardium and abdomen. He was being tapped at frequent intervals, and his liver was very large.

In 1916 this man was again admitted to the hospital, and the diagnosis of ascites, cirrhosis of the liver, cardiac arrhythmia with auricular fibrillation was made. In 1919 he was admitted to the hospital half a dozen times and was incapacitated. Last October he entered the hospital, after having been tapped repeatedly, for operation with the view of establishing a collateral anastomosis. The abdomen was open above the navel. The liver, which had been very large, had become markedly smaller and smooth; the edge was rounded, and it looked like a "beautifully iced cable," the capsule being one inch in thickness. The omentum was brought through

and sutured to bare surfaces of the parietal peritoneum. There was no denudation of the liver or spleen and no drainage, since it had been observed that that procedure markedly increased the operative mortality. In this case the attempt was made simply to establish the collateral circulation between the omentum and the abdominal wall, with the knowledge that the fluid would recur. It was now about four months since the patient had been operated upon, and he had been tapped twice during this time, a large amount of fluid having been obtained each time, but both the interval between the tappings and the amount removed were steadily decreasing. The most striking feature in the case is the improvement in the general condition. The man's appetite has returned, he is stronger, walks better, and is almost ready to go back to work. It is reasonable to expect that in the course of the next six months the recurrence of the fluid will have completely ceased, the collateral venous return having by that time become established.

Doctor Lyle said that in 1913 he had performed Routte's operation for cirrhosis of the liver, and there was a temporary improvement. The patient died two or three months later. At the autopsy it was found that the anastomosis between the peritoneal cavity and the right saphenous vein was patent, while the anastomosis on the left was blocked by fibrous tissue.

Doctor Whipple asked Doctor Eliot if he had had any difficulty in getting sufficient omentum through for suture to the parietal wall. In some cases the peritoneum and omentum were so altered and atrophied that it was difficult to do this.

Doctor Eliot said that in view of the possibility of an atrophic omentum he always made the incision above the navel and not below. He had fortunately never found the omentum so atrophied that it could not be stitched in the manner described to the abdominal wall. The operation he called a modified talma.

THE OVERHEAD SUSPENSION FRAME

Dr. Henry H. M. Lyle read a paper with the above title, for which see page 760, June, 1920.

Dr. Joseph A. Blake thought there was distinct danger in using a splint that brought the elbow to the body in the treatment of high fractures of the humerus, as there was likely to be a limitation of abduction afterwards. Suspension had given excellent results in all cases. There was no objection to it except that the patient had to stay in bed, and that was not a great objection, considering the rapidity with which repair takes place. Considering the fact that function was absolutely maintained, several weeks were well spent in suspension. Doctor Blake said he had noticed that stiffness took place so rapidly that he never allowed the use of a sling or kept the arm at the side for any length of time. He left the arm free during the day and put it back in the suspension apparatus at night. During the night the man moved his arm and in this way union was often obtained in eighteen or

twenty days. The average number of days to obtain complete union, including all cases infected as well as clean, was, he thought, about thirty-two. Of course, in some cases non-union occurred. A certain amount of movement between the fragments did not interfere with union. The old idea of fixation by plaster and other splints in the treatment of all fractures had been exploded, as it had been shown to be not only unnecessary but pernicious.

SEHRT'S METAL TOURNIQUET FOR ARTIFICIAL ANÆMIA IN AMPUTATIONS

Dr. Willy Meyer stated that in looking through the foreign literature in the summer of 1916 he read an article by Sehrt, of Freiburg, in the *Münch. Med. Wochenschr.* of May 25, 1915, in which he claimed that this method was very superior to every other method known to produce artificial anæmia. It had interested him, and he had followed it up. He had asked the Kny-Scherer Company to import the device for him. As the war came on, it could not be done. But in the fall of last year they asked him if he still wanted it. He said he did, and the apparatus reached him in December, 1919, and he started using it in February, 1920. He had a case of amputation of the thigh in which he made use of this method with the greatest satisfaction, and he had also used it in a secondary operation for recurrent sarcoma of the thigh on the posterior aspect. He thought it would be interesting to the Society to see the apparatus and to learn how it was employed. In looking over recent literature, he found that Doctor Truesdale, of Fall River, had described the same apparatus in the *Journal of the A. M. A.*, of January 31, 1920. Lieut.-Col. J. M. Flint and Lieut. A. Dayton had found this in an advanced surgical hospital which the Germans had evacuated after the battle of Saint Mihiel. Doctor Truesdale said it was sent on to his hospital for trial. He had modified it to a certain extent and found it a great advance over other methods of producing artificial anæmia.

The instrument was made on the principle of a clamp, with two curved arms of steel which in emergency could be covered with cotton or gauze, in times of peace better with rubber tubes. With the screw widely open it could be pushed over the limb, where it was made to compress the large vessels and the screw closed. With a few turns of the screw one obtained complete anæmia. It could be applied high up on the thigh, right in the crotch. They all knew how difficult it was to apply an Esmarch's bandage so high up. Its application was extremely simple, as nothing else was necessary except to tighten the screw, and if, during an amputation or a tumor extirpation, it was not entirely compressing the circulation, all one needed to do was to tighten it a little more. When one began to tie the vessels there was not the annoyance of loosening the elastic bandage. A few twists of the screw to the left, leaving the sterile drapery undisturbed, allowed the return of the circulation.

Doctor Sehrt at first thought this tourniquet should be given to all the

soldiers, but said himself that that was incorrect, as it could not be applied for too long a time. But it should be given to advanced posts and stretcher-bearers, as by its use much hemorrhage and many deaths might be avoided.

The instrument described in the *A. M. A. Journal,* Doctor Meyer said, was a slightly modified form of that used by the Germans. The two arms are longer and heavier; an oblong slot is made through the centre of the handle through which passes the screw. This adjustment screw may be pushed either way, releasing compression or renewing control with the greatest ease.

Sehrt's tourniquet represents the greatest advance made in late years for the production of artificial anæmia. It is very simple and efficient and absolutely reliable.

Stated Meeting held March 24, 1920

DR. ALFRED S. TAYLOR in the Chair

SARCOMA OF THE BREAST

DR. BURTON J. LEE presented a specimen of sarcoma of the breast which was removed on December 2, 1919. The patient from whom the tumor was removed had been conscious of its presence for almost a year. She was mentally incompetent and much emaciated, but otherwise physical examination was negative as far as local or general metastases were concerned. The mass occupied the entire breast and was irregular in consistency; the major portion was definitely solid with a few small cystic areas. The circumference of the pedicle was 19½ inches. It measured 27½ inches in the longest and 23½ inches in the shortest diameter. The weight was 10 pounds. There were many superficial dilated veins over the entire skin covering the growth. There was no evidence of involvement of axillary or supraclavicular nodes.

At operation, under local anæsthesia, the tumor was dissected away, the muscle and fascia overlying it being exposed as the breast was removed. The whole area was skin-grafted, but primary union having failed a second skin grafting was done which was successful. Both skin graftings were done under local anæsthesia. The pathologist's report by Dr. James Ewing showed in the gross a tumor with broadly lobulated structure, the lobes being 2 to 6 cm. in diameter. Most of these lobes were necrotic, many infiltrated with blood, and some were soft and opaque. There were no cysts and the tumor was well encapsulated everywhere.

The microscopic examination revealed the general structure of a large spindle-celled sarcoma. The most prominent feature was the large number of huge giant-cells with multi-lobulated nuclei. The tumor probably arose from a fibroma but no remnants of breast tissue could be detected.

The reasons for presenting the specimen were: (1) The relative infrequency of sarcoma of the breast. (2) The unusual size of the growth. (3) That it was possible to remove a tumor of this size under local anæsthesia. (4) That a tumor as advanced as this one emphasized the great need for

establishing a breast examination clinic where presumably normal women might go at intervals when early tumor of the breast might be discovered.

Dr. Frank S. Mathews related the case of a woman who consulted him for a number of shot-like masses in the scalp, at first covered by epithelium but which, if injured by a comb, bled rather furiously. On questioning the patient, she was found to have had a breast tumor removed six months before. This had been pronounced benign at the time. No other recurrences were apparent. She died two or three months later. Histologically, the scalp tumors were pronounced malignant angioma.

OPERATIVE TREATMENT FOLLOWING POTT'S FRACTURE

Dr. Royal Whitman presented a man thirty years of age who was first seen in January of the present year, having been injured six months before. He presented a typical equinovarus deformity with almost complete disability. The internal malleolus was ununited and displaced toward the interior of the joint. The external malleolus was bent outward and separated from the tibia. The object of operation in such cases was to replace the foot beneath the centre of the leg and to restore dorsal flexion and adduction. To accomplish this the external malleolus was almost completely divided from above downward in an oblique direction, so that its extremity could be pushed inward by opening a gap between the fragments, into which a fragment of bone was inserted. The internal malleolus was replaced, the surfaces of the fragments freshened, and a thin bone graft was slid downward from the tibia to cover the line of junction. The tendo achillis was then divided and the foot in an attitude of adduction and right angular flexion was fixed in plaster.

This patient began to bear weight on the foot as the discomfort lessened, and eight weeks later the plaster was removed; the correction was satisfactory and the union at the point of grafting well advanced, as shown in the accompanying picture (Fig. 1).

The shoe was thickened on the inner border, a flat-foot brace was applied, and the patient instructed in exercises and the proper method of weight bearing. This was of great importance for functional cure, since even when the fracture had been properly treated the tendency was toward the passive or flat-foot attitude during the period of reconstruction. This must be checked by exercises in dorsal flexion and adduction and by assuring proper balance in weight bearing.

Dr. Nathan W. Green said that these old cases of Pott's fracture in which there had been bone deformity for a long time were economically very important. He had had one or two of these disabling cases at the City Hospital. He had not done a periosteal graft, but had rebroken them and put them up in inversion, taking care to keep the mortise closed up, and had been fortunate in getting good results in this way.

Doctor Whitman, in answer to a question as to whether bone grafting was absolutely necessary, said that it was unnecessary except for ununited fracture of the malleoli.

FIG. 1.—Shows the correction of deformity and the bone grafts on either side, also the original fracture of the fibula.

PEDICLE GRAFT REPLACING ABLATED HEEL

DR. NATHAN W. GREEN presented a laborer, forty-two years of age, who was admitted to the Surgical Division A of St. Luke's Hospital on April 14, 1917. By the courtesy of Doctor Downes he was turned over to Doctor Green for treatment. His complaint was a painful and tight cicatrix of the right heel with an ulcer on the under surface. This condition was from an injury sustained nine months previous to his admission. The injury was caused by a large paper roll which ran against his heel, removing the skin and cushion of the heel. He was at once taken to a hospital. The wound healed, but whenever he tried to use his foot it would break down and was very painful.

On April 23, 1917, the first stage in the operation for plastic repair was done by Doctor Green. On the sole of the foot a small granulating area was present, the whole right heel being covered with a thin cicatrix. The cicatrix was dissected away from the heel down to the periosteum and ligaments and a large flap, comprising all tissues down to the muscle, was dissected up from the left thigh just above the knee. (This flap was made with its pedicle so placed that it might be elongated and applied to the heel at a subsequent sitting.) The right heel was brought into apposition with the flap which was sutured over the denuded area of the heel. A plaster case was applied from the waist down, holding the heel upon the opposite thigh.

Two weeks later, May 7, 1917, the second stage of the operation was performed. The flap that had been dissected up and applied to the heel was found to be healthy and growing. (Two weeks was thought to be sufficient time for the first part of the flap to have united.) The case around plastic juncture was removed. The flap on left thigh was dissected somewhat further and sutured over the denuded area of right heel with No. 1 chromic gut. The denuded area was now completely covered over except at one place. The plaster case was replaced.

Again, two weeks later, May 21, 1917, the third stage of the operation was performed. The case was removed and the flap found to be viable with practically no slough. The pedicle of the flap was cut loose from the left thigh and sutured to the right heel at the only remaining free point. The wound on the thigh was closed partially and small Thiersch grafts were placed upon the granulating area. The heel was dressed with dry dressing.

The patient was discharged July 6, 1917, with the following note: "Inner side of flap has united perfectly. A small sulcus persists on outer side of heel, which, however, is lined with epithelium" and is "entirely healed." "Motion is somewhat restricted, but improving."

The patient was absent from the hospital for one and three-quarter years and had been working. On account of a small pressure sore on his heel he was readmitted April 14, 1919. On readmission on the plantar

surface of graft was an area of induration about 2 cm. in diameter. In the centre of this area there was a small ulceration.

On April 16, 1919 (one and three-quarter years later), a small operation was performed, excising the scar tissue and ulcer, between the os calcis and the heel of the shoe. There was then an ulcerated area of scar tissue about the size of a half dollar. A circular incision was made about the scar tissue. This tissue was dissected free and excised. A small area of the scar tissue deep in the subcutaneous tissue was dissected free and excised. The wound was closed with interrupted sutures of chromic gut. Dry dressing was applied. He was discharged May 9, 1919, improved and is now, March 24, 1920, cured.

The after treatment consisted of directing the patient to follow a suggestion of Dr. P. G. Cornish, Jr., who was then House Surgeon, of wearing within his shoe, under the grafted heel, a rubber bath sponge. This served to distribute the pressure over the entire surface of the graft between the os calcis and the heel.

This case Doctor Green said was shown on account of the general interest which was attached to a large pedicle graft subject to pressure in this anatomical location. It would be seen that the main part of the graft was soft and that hair was growing upon it and that it had now partaken of the nature of the original skin of the heel.

Doctor Whitman presented a boy fifteen years of age in connection with Doctor Green's case. At the age of five the right foot had been crushed by a street car. He remained in a hospital for two years, for skin grafting and the like, but healing had never been complete. The foot was much atrophied, motion was fairly free in all directions. The heel and the surrounding parts were covered with scar tissue which was firmly adherent to the bone and presented in the sole several ulcers. It was proposed to remove the irregular surface of the os calcis and to apply a flap as in Doctor Green's case.

SARCOMA OF THE ETHMOID (THREE AND ONE-HALF YEARS AFTER OPERATION)

Dr. A. V. Moschcowitz presented a woman, twenty-two years of age, whom he had presented before the Society about two and one-half years ago, one year after the operation was performed. She was admitted to Mt. Sinai Hospital a little over three and one-half years ago, at which time she complained only of the disfigurement, which was caused by a unilateral exophthalmos. After a very careful examination by various members of the rhinological and ophthalmological staff, it was concluded that the exophthalmos was caused by a sarcoma, originating in the ethmoid bone, which pushed the eyeball forward and outward. Vision was retained. The problem presented was how to remove the growth in a radical manner, retaining vision, and without any disfigurement. Doctor Moschcowitz evolved the idea of making the incision in the eyebrow

and down just to one side of the middle of the nose. The sarcoma which originated in the ethmoid was extirpated. Both the primary and late results were excellent.

Dr. Winfield S. Schley said this case demonstrated that extensive sarcoma and the squamous-celled type of carcinoma were in many cases distinctly operable in the region of the superior maxilla. Doctor Schley had operated on a number of cases considered inoperable by other surgeons, and a number of these cases had gone several years without recurrence. One patient who seemed almost hopeless for surgery had gone seven years and was alive to-day. Both sarcoma and epithelioma remained localized for a longer time in this region than in any other part of the body. The glands were involved *very* late. Hence, if one did a wide resection before the growth was far advanced the cases were not only distinctly operable, but the prognosis very fair indeed. In fact, the results were far better than had been thought, but depended directly upon the thoroughness of the primary operation. Furthermore, recurrences were local and *not metastatic* in the great majority of instances. If metastatic they were in the neck glands. These should be thoroughly dissected at the time of the primary operation or at a period before it, whether palpable or not.

Doctor Moschcowitz said that the operation in this case began with an incision extending from the middle of the eyebrow and over the nose, a little to the left of the centre. In order to gain good exposure and access to the tumor he now made an incision through the periosteum from the root of the nose outward and downward, and a similar incision at the junction of the nasal bone and the cartilage. The underlying bone was sawn through and fractured in such a fashion that it hung externally upon a periosteal pedicle. The nose was then opened into and the structures of the orbit, including the pulley of the superior oblique, were peeled back. The eyeball was protected by a spoon-shaped instrument. This procedure exposed the tumor, about the size of the end of a finger, attached by broad pedicle to the os planum of the ethmoid. It was removed with rongeur and chisel. Just after having had this case he had two other cases of sarcoma of the ethmoid. The condition was exceedingly rare, and he supposed he would never see another case of that kind. In the second case Doctor Moschcowitz did an evisceration of the entire orbit, saving the eyelids, with which to subsequently line the orbital cavity. The third patient was a very far advanced case, having been treated at other hospitals with palliative operations and with radium, and died after evisceration of the orbit, with metastases in the brain.

ANEURISM OF RADIAL ARTERY

Dr. A. V. Moschcowitz presented the excised specimen of an aneurism of the radial artery which occurred upon his service at Mount Sinai Hospital. By way of introduction Doctor Moschcowitz stated that amongst

the drawbacks of Dakin's solution it was often asserted that it was the cause of secondary hemorrhages. His experience had been, however, that Dakin's solution had no effect whatsoever upon well vitalized tissues, and therefore he could not see how it could destroy a blood-vessel. It has been the doctor's experience, that whenever an appreciable hemorrhage occurred, it was due to other, usually mechanical, factors. He had seen one rather alarming hemorrhage in a case of empyema, which was ascribed to Dakin's solution, but was proved to have been caused by the pressure of a drainage tube upon the intercostal vessels. As he was on the constant lookout for such occurrences, Doctor Moschcowitz was not at all surprised at the findings of the case under discussion.

This patient was admitted to Mount Sinai Hospital with a very extensive phlegmon of the forearm. The operation consisted of a thorough opening up of the various intermuscular septa, and subsequent treatment with Dakin's solution, instilled through numerous tubes. The wound cleared up very rapidly and the patient was about ready to be discharged with a superficial granulating wound. Routine examination prior to his discharge revealed a pulsating swelling, about the size of a marrowfat pea, upon the radial artery at a point just where it was crossed by a Carrel tube. The case was watched with great interest for twenty-four hours, during which period the aneurism had increased to double its size. On the following day the aneurism was extirpated in local anæsthesia.

The hardened specimen showed an aneurism of the size described, communicating with the radial artery. The specimen and its exact histological examination will be described in a future paper.

Doctor Moschcowitz said this case proved the following two points: First, that secondary hemorrhages were not caused by the chemical action of the Dakin's solution; and second, that great care must be used in placing rubber tubes in the vicinity of vessels.

CALCIFIED EPITROCHANTERIC BURSITIS SIMULATING SARCOMA

Dr. N. W. Green presented a girl, seventeen years of age, who was admitted to the Surgical Division A of St. Luke's Hospital on July 16, 1919, on account of a tumor on the right hip. About four months previous to admission the patient fell on her right side and bruised her hip. One month later she began to have pain in the side, which was increased by walking. She noticed a distinct tumor growth on her hip since the time of her injury.

Her past history was unimportant. Physical examination showed a well-nourished girl presenting a tumor in the region of the right hip just below the base of the great trochanter. The tumor was hard, fixed, and slightly tender.

Operation was performed on July 17, 1919, under gas and ether anæsthesia (Doctor Green).

Pathological findings: There was a mass 6 inches long and 3½ inches

FIG. 2.—Calcified epitrochanteric bursitis simulating sarcoma.

broad, well encapsulated and adherent to the gluteus maximus muscle. The tumor mass was soft, slightly irregular, and contained an area of broken-down material as shown after removal. The mass was situated beneath the fascia of the tensor fascia femoris and the gluteus maximus muscle.

Operative procedure: A long incision was made extending from above the great trochanter down the femur for a distance of 8 inches. The skin, fat, and fascia of the tensor fascia femoris was retracted and separated from the mass on the anterior and lateral side. A portion of the tensor fascia femoris was mutilated in order to get below the tumor mass, which was found adherent to the gluteus maximus muscle. It required the removal of a large part of the gluteus maximus muscle in order not to cut into the mass. (The idea being even at this stage of the operation that it was a fibro-sarcoma.) The mass was removed in its entirety. Bleeding points were ligated and a rubber dam drain inserted. The skin was closed with interrupted sutures of chromic gut and a dry dressing applied. The patient was discharged cured thirteen days after operation. At present she shows no limp and has good motion in every direction.

Pathological Diagnosis.—A calcified bursa situated over the great trochanter.

This case was shown on account of its similarity to a malignant growth and to show the excellent function after a large part of the gluteus maximus muscle had been removed.

X-ray findings: The röntgenogram (Fig. 2) taken by Dr. L. T. LeWald shows a large mass mottled in appearance which shows the presence of lime salts in juxta-proximity to the great trochanter.

This latter, in view of the post-operative findings, proved to be due to a calcification in the bursa. Before operation, and even at the time of the operation, the tumor was thought by several men to be of a malignant nature.

MECHANICAL FACTORS IN THE MANAGEMENT OF RECENT EMPYEMAS

Dr. Frank S. Mathews read a paper with the above title.

Dr. Howard Lilienthal said there were a few points he would like to add to those brought out in Doctor Mathew's paper. First, he would like to add a fourth to the list of the objects of the operation, and that was the prevention of deformity; that was important and should always be borne in mind. Doctor Mathews mentioned that the lungs only contracted by the action of elastic fibres. He thought the lungs contracted because of the intrinsic muscle fibres in the lungs.

In reference to the action of the lungs in cases of traumatic atelectasis, usually this form of atelectasis was confined to one lobe, and that lobe would be so absolutely contracted that it would be like a piece of thick limp leather, and, strange to say, one could not inflate such a lung through the pharynx. This seemed to be due to a spastic condition of the lung itself, and he thought it was a protective effect. He had noticed this behavior

of the lung in gunshot wounds where there were spiculæ of fractured rib in contact with the lung, and the lung seemed to have contracted away from the object that was producing the traumatism. Atelectasis usually occurred in the lower lobe but it sometimes occurred in the upper lobe. So he thought there was something more than the elastic fibres concerned in the production of the condition. Doctor Lilienthal said he had suggested in a report to the surgeon general that this would be a good subject to study by animal experimentation to see if it was possible to produce experimental traumatic atelectasis.

As to suction methods, he did not think much of these methods. There had been four or five cycles during which suction methods had been discovered and rediscovered. All had failed. The thing of importance in dealing with empyema was that one was not merely dealing with pyothorax. It was not like a sac of fluid that could be opened at the bottom and drained. It was a condition so multiform that one must have done a large number of operations where there were large exposures to fully appreciate this feature, and one must also have studied the chest with the X-ray.

All these points Doctor Mathews brought out should be considered, but there were other points of equal importance. One of these was the binding down of the lung by dense exudate which rather rapidly became true fibrous tissue and then it took a long time for expansion to occur unless the exudate was removed by the method of Delorme, Fowler, or Ransohof. The patient had to take coughing or blowing exercises in order to keep the lung inflated enough of the time to prevent the exudate from reforming, and retraction again taking place. If much of the lung was bound down healing depended upon two things, either one must get rid of the adhesions and exudate or produce a sterile pneumothorax. In the latter case there would be healing and afterward a gradual expansion of the lung, obliterating the pneumothorax.

Another point that one could not too often emphasize was that multiple pockets were extremely common, so common that one could almost say they were the rule in empyema due to infection through minute and perhaps microscopical openings in the surface of the lung. One could not say that every empyema was caused by minute lung abscesses, but we knew that empyema resulted from large lung abscesses, and it was probable that many empyemas were caused by these tiny abscesses, and there might not be the same organism in each abscess or sacculation. If the sacculations were in different parts of the pleura they had to be done away with either by doing away with all the adhesions, which was a safe and proper method, or else by making a sufficient number of openings to explore and drain every cavity. Only the other day Doctor Lilienthal said he had a woman very ill with empyema. He made a puncture and found the hæmolytic streptococcus. He had demanded an X-ray examination and this showed a general opacity of the chest, but

there was one shadow toward the front of the chest, circular in form and more dense than the rest. He predicted that at least two cavities would be found. He opened the posterior cavity and found brown pus which was very thin and contained the hæmolytic streptococcus, as was reported by the medical men who did the puncture some days before operation. A second opening was then made to expose the area in front where the second shadow was located. This opening was made in the fifth interspace near the pericardium. He had been rash enough to predict that he would find green pus, and indeed, this was encountered. The culture showed staphylococcus aureus. These cavities were opened by different incisions and treated separately in the endeavor to keep the hæmolytic streptococcus from getting into the other cavity. This case illustrated what he meant in reference to operation. If this patient had been strong enough to have stood it he would have done a larger operation, using the rib spreader. Doctor Lilienthal said he had seen cases with four different cavities and four different kinds of pus. While one might succeed in clearing up the empyema by draining one abscess at a time, it was better when possible to make a wide exploration, exposing all parts and opening all sacculations at one sitting.

Dr. Walton Martin stated that he was in favor of the views expressed by Doctor Mathews. Doctor Mathews called attention to the fact that the lung expanded at the end of three or four days in many instances. He had recently read an autopsy record of an extensive suppurative pleurisy in which the entire chest was involved. The patient had been drained by a wide intercostal incision and on the sixth day died from heart disease. At autopsy the lung was almost entirely in contact with the chest wall and only a small collection of pus remained.

Dr. A. V. Moschcowitz would put the mechanics of the cure of the malady in about the following manner: Up to three or four years ago there was only one method of treating an empyema, and therefore the mechanics of the cure consisted in one thing; namely, slow expansion of the lung and its adhesion to the chest wall. During the last four years other methods of healing had been evolved, and the mechanics of the cure were entirely different. It was shown by Tuffier and others at the War Demonstration Hospital of the Rockefeller Institute that an empyema cavity could be sterilized by means of Dakin's solution, and, when sterile, the external incision could be closed by secondary suture. In a certain number of cases permanent healing resulted; and these permanent cases proved an entirely new principle in the healing of empyema. Finally, Doctor Moschcowitz stated that he had a very interesting experience in one of the cases under his care at General Hospital No. 12. In this particular case routine physical examination, subsequently verified by X-ray examination, showed that a case healed for quite some time had a very definite pneumothorax. The case was watched with great care, as it was feared that a recurrence of the empyema would take place.

Much to Doctor Moschcowitz's gratification, the unexpected occurred; namely, instead of a recurrence, there was found a disappearance of the pneumothorax. It was this case that gave the clue for the procedure subsequently adopted. Whereas up to that time operations for the cure of chronic empyema were of almost daily occurrences, all operations ceased. Instead, when definite sterility was obtained in a case of empyema, all treatment was discontinued, and the outer opening was merely allowed to close. The mechanics of the last method were very interesting. The expansion of the lung which occurred could best be explained upon the theory that the air within the pneumothorax became absorbed, thereby creating a vacuum which aided in the expansion of the lung.

Dr. Alfred S. Taylor said that a skin flap could be made that acted like a valve. This allowed the pus to come out, and after each expulsion the flap came back against the opening and created a partial vacuum in the pleural cavity. Such a flap had been found to work well in children, and the lung was found down to normal range on the second day.

Doctor Mathews, in closing, said he removed drainage tubes much earlier than formerly. After their removal he considered air in the cavity a disadvantage. Doctor Moschcowitz had mentioned the sterilization of the cavity by antiseptics, but he considered it safer to have a cavity obliterated by apposition of its walls rather than leave a pneumothorax. Very little was said in the literature about the method of lung expansion. Bronchial communications in empyema seemed commoner with a streptococcus infection. Even with such infections, they would seem to be comparatively infrequent as was shown by our ability to aspirate the fluid without producing a pneumothorax.

Stated Meeting held April 14, 1920

The President, Dr. William A. Downes, in the Chair

SUBPERIOSTEAL RESECTIONS

Dr. James I. Russell presented five patients of whom all except one, the subperiosteal resection of the humerus, had been shown to the Society before. In none of these cases had there been secondary foci and none required further operation after the primary operation for removal of the shaft. With this operation the convalescence was slow, but it was rewarded with permanent cure.

Case I.—The first patient, who had a traumatic separation of the lower epiphysis of the right femur, was shown before the Society October 23, 1912, one year after operation, when he was five years old. Doctor Russell said he presented him now, nine years after operation, to show the final result. There was perfect function and no shortening. He was shown to demonstrate that there had been no arrest in the growth of the bone.

Case II.—This patient, Doctor Russell said, had had a subperiosteal

resection of the fibula, reported and shown before the Society January 28, 1914, at which time the fibula was not completely regenerated. The X-ray, at the present time, still showed the fibula not completely regenerated. The patient's function, however, was excellent, and it might be that in this bone, bearing so little of the body weight, Nature had not found regeneration necessary.

Lantern slides showed the process before operation, at the end of the first, second, third, sixth, and ninth months following operation, and three and seven years after the operation.

CASE III.—Doctor Russell stated that this patient, who had a chronic suppurative osteomyelitis of the shaft of the right humerus, had never been reported. He was admitted to Roosevelt Hospital March 12, 1914, at the age of seventeen years. Five weeks before his admission to the hospital he struck his arm above the elbow and suffered some pain immediately. Five days later he had severe throbbing pain in arm above the elbow, was feverish and very ill. The forearm was swollen. He was in bed for ten days when the pain became somewhat diminished.

When admitted to the hospital the right arm was held in position of mid-flexion. There was one-half inch of atrophy of the upper right arm as compared with the left. The skin was not reddened nor hot. The upper arm had a firm, brawny consistency. There was tenderness over the entire upper arm, except the upper third; it was thickened and there was marked tenderness on the outer side of the humerus. The white blood-cells numbered 16,000, and polymorphonuclears 81 per cent.

At operation, two days after admission, a subperiosteal resection of the greater part of the shaft of the humerus was done. The periosteum was more calcified than any other case on which Doctor Russell had done this operation. It separated in flakes rather than as a thickened membrane. The patient was discharged from the hospital one month later, with the arm in a plaster cast.

X-rays were taken before operation, immediately afterwards, at the end of the second, third, fourth, and sixth months after operation, and the final one six years later. There was no shortening and he had excellent function.

CASE IV.—Doctor Russell said he had presented this patient before this Society January 28, 1914, following subperiosteal resection of left tibia. It was now nearly nine years since her operation, at which time she was eighteen months old. There was about one-half inch shortening of this leg and the child walked with a slight limp.

X-rays showed the condition before operation, one week after, at the end of the first, second, third, fourth, and eighth months, and nine years after operation.

CASE V.—This patient, Doctor Russell said, had had a subperiosteal resection of the right tibia. He was shown before the Society January 28, 1914, five years after operation, which was done at the age of six years. It had now been eleven years since his operation. He had about

one-half inch shortening, and a very slight limp. He has been perfectly well since operation.

Slides were shown at the end of the first month and at intervals of two months throughout the first year after operation, and at the end of each successive year for five years, the last slide having been taken eleven years after operation.

Doctor Whitman thought these late results very satisfactory, indicating that the epiphyseal cartilages had not been damaged by the original disease.

The fibula was very useful as a prop during the regeneration of the tibia after such operations, but under normal conditions only the malleolus was indispensable. As was well known, portions of the shaft were sometimes removed to serve as pegs in the operative treatment of ununited fracture of the neck of the femur without functional impairment.

Dr. Robert T. Morris said that in the case with incomplete regeneration bridging of defects in bone might be done. He had had under his care a boy twelve years of age in whom there was very good regeneration of bone after the removal of the diaphysis of the tibia, excepting at one point where two fragments tapered so that there was a hiatus between the two ends of about an inch. He divided the narrowed periosteum longitudinally at this point and put in a piece of rib and obtained a very good growth of bone. The periosteum also replaced the part of the rib from which the segment had been removed. The question had been brought up as to whether osteoblasts developed from bone or from periosteum. In the case just cited there were apparently osteoblasts starting from the graft in the tibia as well as from the periosteum of the rib.

Dr. Howard Lilienthal asked Doctor Russell if he advised the immediate removal of such large pieces of bone or whether he drained first before doing the resection. He said he had always worked the other way, he had not taken out the entire section of bone until it was pretty well proven to be necrotic.

Dr. Wm. B. Coley asked how long extension had been kept up in those cases.

Dr. Seward Erdman asked Doctor Russell just what he meant by primary union in these cases; whether he understood correctly that he removed the osteomyelitis and then closed the wound by primary suture.

Doctor Russell, in answer to Doctor Lilienthal, said that in very acute cases he did not think it desirable to do an immediate subperiosteal resection; thought it better to do a primary drainage, removing the cortex of the bone, and in about three or four weeks, when the periosteum had thickened sufficiently, to do a secondary operation, removing the shaft. In the last case shown, which was an acute case, primary drainage was instituted and a subperiosteal resection of the shaft was done three weeks later.

In reply to Doctor Coley's question about extension, no extension

was used except in the case of the humerus; where, as Doctor Whitman had said, there were two long bones the healthy bone acts as a splint to the diseased one and extension was not necessary. The only case in which extension was used was in the subperiosteal resection of the humerus, where extension was continued for about six weeks after the patient left the hospital, making about two and one-half months in all.

In reply to Doctor Erdman's question as to whether primary suture was used; as a rule, these cases were infected and do not heal by primary union. In the fourth case, of nine years' duration, in which there was a chronic process with a sinus in the lower end of the shaft of the tibia, primary union was obtained throughout both the periosteum and the skin with the exception of a small drainage point just above the lower epiphysis. The other cases were all drainage cases.

EPITHELIALIZATION UNDER VOSBURGH'S METHOD OF STRAPPING

Dr. Seth M. Milliken presented a man who was admitted to the Lincoln Hospital after a steam burn which burned off the posterior one-half of his scalp, an area on his shoulder, over the scapula and under the arm. Doctor Milliken said he saw the patient for the first time when he came on service at the Lincoln Hospital on February 1st. At that time large areas of sloughing had occurred. The sloughing area on the patient's head was a little larger than his hand. The area over the scapula was about 4 by 7 inches in extent. He had a burn over the olecranon and under the arm. Exuberant granulations were heaped up in these areas.

Doctor Hitzrot, some time ago, had shown a case in which following a burn he had done a skin transplant on the scalp, and it seemed that in this case it would be necessary to follow such a procedure. It was then decided to try Vosburgh's method of strapping. Small grafts were taken off the chest and arm for this purpose, and nothing had been done except to pull the margins of the wounds towards each other. The last graft was put on by the house surgeon one week ago Monday.

The advantage of Vosburgh's method of strapping was that there was less cicatrization than by any other method; the results were much better than by the application of boric ointment or any other form of treatment. The edges of the wound were gently approximated and then adhesive plaster was applied tightly to hold the granulations as flat as possible. This kept the surface in good condition. Nothing else was done in this case except to apply the grafts and strap the granulations absolutely flat.

Dr. Royal Whitman said that the use of adhesive plaster strapping for the purpose of levelling the granulating surface of an ulcer and approximating the margins of the skin was a very old treatment, as was its use in connection with skin grafting of the Reverdin type. Doctor Vosburgh had apparently revived and improved a method that had fallen into disuse.

Dr. Howard Lilienthal said he felt pretty sure that this was not a

rediscovery, as Doctor Whitman said, because there was no such thing as F. O. adhesive plaster in those days to which Doctor Whitman referred. He felt quite sure of this, because he had introduced F. O. adhesive plaster himself. It was an improvement on a European plaster. Before that time they used a lead plaster which was used with the idea that it was protective and also to draw the wound edges together. Doctor Lilienthal said that as he understood the Vosburgh method the grafts were glued to the plaster and then the plaster applied, so as to hold the grafts on to the granulations. The plaster did not pull, but was simply a dressing laid on. At the same time, Doctor Lilienthal said he would like to mention another method that was extremely valuable. It was not original with him and he did not know who had originated it. It was a method of grafting infected granulating wounds by first using the Carrel method and getting the granulating surface perfectly germ free and then laying on the graft with a paraffine mosquito-net dressing. Dakin's solution was then applied as a wet gauze dressing once a day. The original paraffine mosquito-net dressing was allowed to remain for ten days. By that method every graft would take if there were no bacteria in the wound. This was better than the Vosburgh method, though he also approved of that.

Dr. H. M. H. Lyle said that in 1915 and 1916 they had used sometimes rubber and sometimes open-mesh material and paraffine as the routine treatment in extensive burns. This method was very satisfactory; with it one might expect almost 100 per cent. of successes.

Doctor Milliken said that zinc oxide plaster was sterile and protective, and if put on firmly kept down granulations and the marginal epithelium formed more rapidly. All he did was to put the graft either on the adhesive plaster or on the granulations and press it down firmly. The new epithelium advanced very rapidly and the zinc oxide kept the surface moist and smooth.

THE METHODS AND RESULTS OF TREATMENT OF CRANIOCEREBRAL WOUNDS

Dr. Harold Neuhof read a paper with the above title, for which see October Annals of Surgery.

Dr. Burton James Lee said there was one point that should be mentioned in connection with the mortality of head wounds and that was that a large number of those who received head wounds died in the front area, and if one is considering the mortality of head wounds as a whole, these must also be included. The complete records should include all those who died of head wounds in the front hospitals, and also many who died in ambulances on their way to the rear.

Dr. John Douglas spoke of two points in connection with Doctor Neuhof's paper that were applicable to civil surgery. One of these was the implantation of fascial flaps in the dura. He had used such fascial

flaps in two operations for traumatic epilepsy and also in a third case, that of a child on whom had dropped a vichy siphon from the fifth story of a tenement, which crushed the skull so that it was like a broken egg shell, with the brain tissue protruding. The dura was impossible to close. By taking a large flap of fascia from the child's thigh, it was possible to close the defect in the dura. For a time the child had hemiplegia, but later the child walked with a comparatively slight limp.

Another point that had been mentioned was the difference in wounds made by war missiles with high velocity and those made by revolvers in civil life. In a case in the prison ward at Bellevue Hospital, that of a man who attempted to commit suicide by shooting himself in the right temporal region, the bullet lodged in the left side of the brain, about one and one-half inches from the surface. The man had hemiplegia and aphasia. He was not operated upon and within one month he was up out of bed and had recovered from his aphasia and later had partly recovered from his hemiplegia. It would seem that in a large number of these head wounds if the victim did not die of immediate hemorrhage or brain injury, and if there were no signs of infection, it was safer to leave the bullet in than to extract it by immediate operation.

Doctor Neuhof, in closing the discussion, said that concerning his statistics he had not obtained them through American official channels with a few exceptions. The chief source was directly from patients by letters, and in this way he had been able to keep track of a large majority of these patients. Doctor Neuhof said he had also had access to the statistics of the British Expeditionary Forces which were collected by the Medical Research Committee. That had been an additional source of information, particularly in regard to reoperated cases. The mortality included all cases up to date. There was no selection of cases for operation in those he had considered; they were taken just as they came under their care. At Mobile Hospital No. 2 Doctor Neuhof said he was in a position to make a certain selection of cases, and he chose the most serious injuries to see what could be done in those cases. No cases were refused operation except those manifestly moribund and those with huge skull defects with the brain extruding that could only live for a few hours or perhaps a day. At his mobile hospital all other cases were subjected to operation.

TRANSACTIONS
OF THE
PHILADELPHIA ACADEMY OF SURGERY
JOINT MEETING HELD WITH
THE NEW YORK SURGICAL SOCIETY

February 2, 1920

DR. GEORGE G. Ross in the Chair

CASE OF JACKSONIAN EPILEPSY CAUSED BY BRAIN TUMOR. SUCCESSFUL REMOVAL OF THE TUMOR

DR. A. P. C. ASHHURST reported the case of a patient, John T., thirty-one years of age, on whom he had recently operated at the Episcopal Hospital. The man was originally admitted to the hospital November 22, 1919, complaining of "headache and stomach trouble," and was sent to the Medical Ward, then in charge of Dr. M. H. Fussell; and was eventually transferred to the Surgical Service January 3, 1920, by Dr. John B. Carson, who had succeeded Doctor Fussell on duty in the medical service.

Doctor Ashhurst saw the patient first in consultation on January 2, 1920, and learned the essential facts of the history as follows: The patient's family history was negative. He was unmarried. He was born in Poland and came to the United States in 1912. He was a laborer, and his general health always had been good. He smoked and drank very little and had had no serious injuries and no operations. He denied venereal disease.

About a year ago the patient had his first convulsion, losing consciousness. Since then he had had eight other attacks of varying severity at intervals of weeks or months. Three weeks before admission (*i.e.*, about November 1, 1919) his family physician, Dr. Jacob B. Feldman, made a spinal puncture for a Wassermann test.[1] After this the patient developed headache and vomiting. In the three weeks elapsing between this visit to his physician and his admission to the hospital, he had five convulsions. If he tried to leave his bed he vomited. After his admission to the hospital, during the latter part of November and during December, he had five other convulsions, one of which at least was determined to be Jacksonian in type, beginning in the left hand.

The patient, while on the medical service, was seen with Doctor Carson by Dr. Charles W. Burr, Consulting Neurologist to the hospital, who was unable to make a diagnosis. It was learned after operation that

[1] This was reported negative, as was the blood Wassermann after his admission to the hospital.

the patient's physician, Doctor Feldman, had called Dr. Alfred Gordon in consultation, and that Doctor Gordon had suggested an operation on account of a bony lump in the skull in the right parietal region, and after seeing a skiagraph of the patient's head.

Examination (January 2, 1920) showed a young man with rather expressionless face, who felt fairly well when lying quiet in bed, except for a constant terribly severe headache, in the frontal region and on the top of the head. The right eye was kept closed or nearly so, but could be opened. The pupils were equal and reacted (rather sluggishly) to light and accommodation. An examination of the eye-grounds made by Dr. Harold G. Goldberg, Ophthalmologist to the hospital, on November 29, 1919, had shown that the right eye was negative, but that the left eye showed slight paleness of the nerve and disturbance of retinal pigment, and one minute hemorrhage of considerable duration down to the temporal side of the disk. Doctor Goldberg considered it a beginning of neuroretinitis. A subsequent examination by Doctor Goldberg, January 5, 1920, confirmed the above findings, but showed no changes since the previous examination.

There was no paralysis of any of the cranial nerves, and the chest, abdomen and genitalia were negative. The extremities also were negative except for slight accentuation of the knee-jerks. There was no Babinski, no ankle or patellar clonus, and no Kernig's sign.

In the right parietal region of the skull was a sessile exostosis, about 5 cm. in diameter and raised about 5 mm. above the surrounding surface. Pressure on this lump caused some pain. He said he noticed the lump first about five years previously, and that it had been very slowly growing larger. Questioned as to any injury to this region, he said that when he first came to this country (over seven years ago) he attended night school, and there were many fights among those standing in line waiting for admission, but he did not remember any specific injury to his head. Skiagraphs made by Dr. R. S. Bromer, Radiologist to the hospital, showed an area of rarefaction of the inner table of the skull corresponding to the site of the exostosis.

Here was a man, Doctor Ashhurst said, who besides having epilepsy, apparently Jacksonian in type, had intense and persistent headache, had unprovoked attacks of vomiting, had an abnormal bony lump over the right motor region, and who had changes in the left eye-ground suggestive of increased intracranial tension. He considered these facts sufficient to justify an exploratory operation. His opinion was that the exostosis itself might be sufficient explanation for the symptoms.

Operation (January 6, 1920).—Ether (intrapharyngeal). Operator, Doctor Ashhurst; assistants, Doctor Mendel and Doctor McGuire. A bone flap, three of whose sides measured about 8 cm. each, and whose base (in the temporal region) measured 3 cm., was turned down from the right motor region, the exostosis being about in the centre of the flap.

Bleeding from the scalp was controlled by Kocher hæmostats. The bone flap was cut by means of the Hudson trephine, Gigli saw, and De Vilbiss forceps. After raising the bone flap its under surface over the area corresponding to the exostosis was found eroded and hemorrhagic in appearance. The bone flap was therefore removed, together with a portion of the cranial aponeurosis which was adherent to the underlying exostosis (Fig. 1). (Time elapsed at this stage of the operation, fifty minutes.) The exposed dura was granular over an area corresponding to the exostosis, and it was determined to excise it. It felt a little less resistant than the surrounding exposed dura, but the entire surface exposed pulsated normally. After ligation of four or five meningeal vessels with fine silk on a curved needle, the dura was opened and a grooved director slipped inside, and a rectangular incision (5 by 5½ cm.) was made with scalpel upon the director, entirely surrounding the diseased dura. As an attempt was then made to raise the diseased dura by mouse-toothed dissecting forceps, it was found to be continuous with a tumor embedded in the brain. By careful preliminary double ligation (with fine silk on a curved needle) of all pial vessels entering the tumor, and dividing the vessels between the double ligatures, it was possible very slowly and cautiously to outline the tumor. By making gentle traction on the edges of the dura, and wiping away the convolutions of the brain with wisps of cotton (moistened in extremely hot salt solution) held in the fingers, the brain tissue very gradually was peeled off the tumor, millimetre by millimetre, the union between the two being like that of inflammatory lymph adherent to the intestines, and the friability of both brain and tumor being nearly as great as that of the flakes of inflammatory lymph. Only at one point was any apparent damage done to the brain, when the needle passed around one of the pial vessels pricked the cortex, which immediately became suffused with a pink color over an area about 1 cm. in diameter. After the region of pial circulation was passed, the remainder of the stage of enucleation of the tumor was almost bloodless, any very minute ooze being promptly controlled by application of wisps of cotton squeezed out of an almost boiling saline solution. The tumor measured 5.5 cm. by 5 cm. on its surface, and was 4 cm. deep (Fig. 2). The hollow left in the brain pulsated normally, but showed no immediate tendency to fill up (Fig. 3). (Time elapsed at this stage of the operation over two hours, about an hour being consumed in enucleating the tumor from the brain.)[2]

[2] The specimen was submitted to Dr. William G. Spiller, at the University of Pennsylvania, who reported, after examining it microscopically, that the tumor could be only one of two things—an endothelioma or a fibroma; and he was inclined to class it as the former. He was further of the opinion that such growths in the brain were frequently the result of irritation from a lesion of the skull, originally traumatic in origin. This had been Doctor Ashhurst's own belief at the time of the operation, and he was glad to have it confirmed by so able an authority as Professor Spiller. Krause [Surgery of the Brain and Spinal Cord; translated

FIG. 1.—J. T., aged thirty-one years. P. E. H. January 6, 1920. Bone flap removed from right parietal region, and containing an exostosis (hyperostosis). Above, the outer surface of the bone, with the portion of the cranial aponeurosis excised because adherent to the exostosis. Below, the inner surface of the bone, grooved by branches of the middle meningeal artery, and showing the rarefied area corresponding to the brain tumor. (Actual size.)

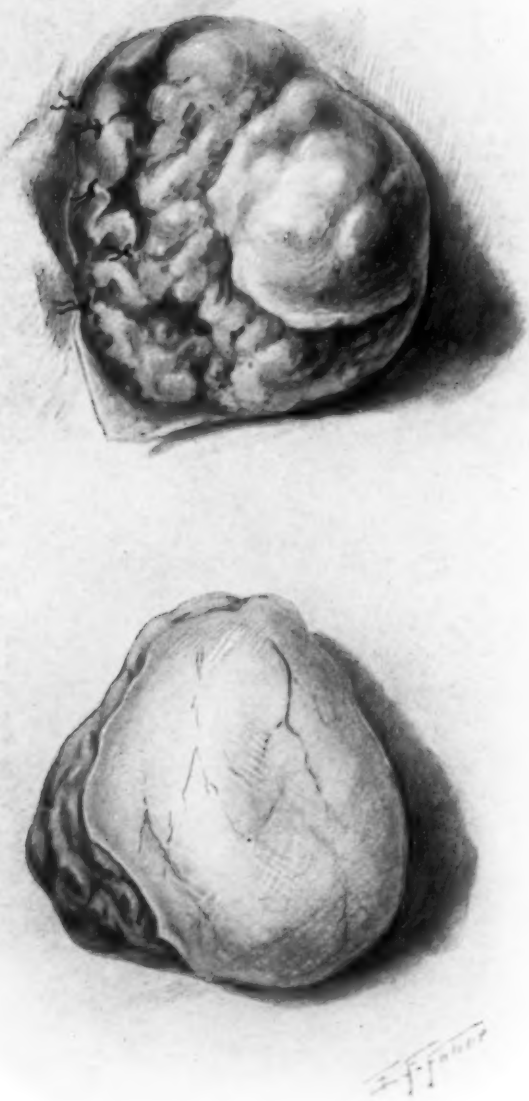

FIG. 2.—J. T., thirty-one years. P. E. H. January 6, 1920. Tumor growing from dura in right parietal region. Above, the cerebral surface of the growth, showing some of the ligatures in the region of greatest vascularity. Below, the cranial surface of the growth, showing the adherent dura excised with the tumor. (Actual size.)

During the removal of the tumor, Doctor McGuire cut a free transplant of fascia lata from the patient's right thigh, and this transplant (a rectangle 5 by 5.5 cm.) was sutured to the edges of the defect in the dura by interrupted silk sutures, and was gently pressed down into the hollow left in the brain. The flap of scalp was then replaced and accurately sutured (without drainage) by interrupted sutures of silkworm gut, the sutures being placed about 0.5 cm. apart, and thus effectually controlling all bleeding from the scalp.

The patient's condition was good throughout the operation, which was three hours in duration, and he left the table with a pulse of 128. At no time subsequently were there any unfavorable symptoms. For the first twenty-four hours after operation he said his left forearm and hand felt numb, but at the end of this time normal sensation returned to all but thumb and index finger. By January 18, 1920 (twelve days after operation), the index finger felt nearly normal, but the thumb still felt anæsthetic, though both index finger and thumb distinguished pin contact throughout. At this time the patient was fairly convalescent. He seemed much brighter than before operation, had no headache at all, but still felt giddy on sudden movements or on attempts to sit up in bed.

January 28th: Sitting up in chair.

February 2d: Four weeks after operation. Walking about ward. Has had no convulsions since operation. If symptoms develop later from the skull defect caused by removal of the bone-flap, it is planned to do a second operation and fill the opening by a bone transplant from the outer surface of the neighboring skull.

June 7: Five months since operation. Has gained thirty pounds in weight. Has had no convulsions since the operation. His ears no longer buzz, but he has some consciousness of his brain in stooping (he has returned to his work as automobile mechanic) and in walking fast. On June 10th a bone transplant was cut from the left parietal region. consisting of the outer layer of the skull and overlying pericranium, and was inserted into the defect in the right parietal region which had been previously prepared for its reception. The patient, who was receiving ether by intrapharyngeal insufflation, was in good condition until the head was turned over to the left, for insertion of the transplant in the right. His condition at once became unsatisfactory, and in spite of stimulation he died, apparently of respiratory failure, as the scalp

by H. A. Haubold; New York, 1909, vol. i, p. 71], however, held the opposing view, that tumors of the dura were responsible for the growth of new bone in the skull. The latter view could justify one in replacing the bone flap after removal of the tumor; whereas, if the former is the correct theory, replacement of the same bone might in time cause another tumor to form. In 1899, Spiller reported a case similar to the one now recorded, and in 1907 reported a second case and reviewed the literature (J. A. M. A., 1907, ii, 2059). In advanced cases the thickening of the skull overlying the tumor becomes so widespread as to justify the name of *hæmicraniosis,* applied to it in 1903 by Brissaud and Lereboullet.

was being sutured. The duration of the operation was nearly two hours, but there was no evidence of shock: he ceased breathing some seconds before the heart beat stopped, and artificial respiration and cardiac massage (through the unopened chest and abdomen) were of no avail. No autopsy was permitted.

HÆMATOMYELIA, WITH CROSSED PARALYSIS
(Sensation on Left, Motion on Right)

DOCTOR ASHHURST also presented notes of the following case. He found the patient in the ward at the Episcopal Hospital when he took over Doctor Frazier's service from Doctor Mutschler, August 1, 1914. For the ward notes he was indebted to Drs. J. Walker Moore and J. P. Jones, the surgical internes.

The patient, a young man twenty-five years of age, was admitted July 23, 1914, and discharged October 29, 1914. On the day of admission at 7.30 A.M. he had been knocked backward from the deck of a ship to the deck beneath, landing on his forehead. He was not unconscious at all. He had no pain for the first five minutes, but then felt intense pain all over the body. After the fall he was unable to move a muscle of his body below the chin, but he could talk and move his eyes and eyelids normally.

On admission, at 2 P.M., the patient is paralyzed below the sixth cervical vertebra. He has great difficulty in breathing. He can talk, open his mouth, and protrude his tongue, but is unable to move his head or the rest of his body. There is no bleeding from the ears or nose.

He was placed on a water bed.

Physical Examination.—Fairly well nourished and developed young fellow. Temperature 102° to 101° F.

Head: Eyes react normally to light and accommodation; pupils are equal. Nose and ears are negative. Tongue is moist and clean, no paralysis. There is an abrasion and some slight swelling of the forehead. Complains of intense pain in the neck when the head is moved. There is no displacement of the spinous processes of the cervical vertebræ. He is unable to move his head at all.

Chest: The breathing is shallow and difficult. Lungs and heart are normal.

Abdomen: No respiratory movements of the abdominal muscles. There is a scar of a hernia operation in right inguinal region.

Extremities: All four extremities are paralyzed. The patellar and cremasteric reflexes are absent. The hamstrings and calf muscles contract when the overlying skin is pricked with a pin. The toes move when the sole of the foot is touched. There is loss of sense of pin prick on the entire left side up to the neck, but this sense is retained on the right side.

Six Hours Later.—Slight motion is perceptible in left arm and left leg; sensation remains about the same.

Ten Hours After Admission.—Is able to move the right arm also; can flex but not extend the elbow. Unable to move the right leg. Breathing is better. Pain is less. Knee-jerks still absent.

July 24th: Can move the right arm slightly. Has to be catheterized. No other changes. Temperature 101° to 100° F.

July 25th: Given a purge.

July 26th: Voided urine, and has control of his bowels. Slight increase in power of triceps in left arm. Fibrillary contraction of both lower extremities. Still unable to move right leg. Cannot move the muscles of shoulder girdle.

July 28th: Can move his shoulder muscles, no other change.

July 30th: Temperature has reached normal.

August 1st: Notes by Doctor Ashhurst:

Can rotate, flex and extend the head, but not strongly.

Right upper extremity: Can move the right shoulder. Trapezius, deltoid and axillary fold muscles all act slightly. Subscapularis, good. Biceps, good. Triceps, no power. No power in wrist or fingers.

Left upper extremity: Shoulder muscles are all good. Elbow good, but weak. Slight power in the extensors of the wrist and fingers.

Left lower extremity: Fair power throughout. Increased reflexes. Ankle clonus and Babinski present.

Right lower extremity: No power; spastic. Increased reflexes. Babinski present. Fibrillary contractures.

Sensation: Over the entire left side from the ninth intercostal space down, sharp and dull are called dull. The remainder of the body has normal perception of sharp and dull. Over the left lower extremity cannot distinguish hot from cold. Over the left abdomen and thorax both hot and cold are felt as hot. Elsewhere sensation of heat and cold are normal.

Neck: Third cervical spinous process appears to be more prominent than normally.

Diagnosis: Hemorrhage into substance of cervical cord; hæmatomyelia.

August 3d: Can flex right knee and hip with ease. No other changes.

August 4th: Skiagraphs negative for fracture of cervical spine.

August 13th: Can turn from side to side in bed, and raise entire body from bed. Sensation continues impaired on left side. Is moved from water bed to ordinary mattress.

August 15th: Good movements in arms and legs, but very little power in the hands.

August 18th: Can sit up in bed. Hands still very weak, but arms are becoming stronger. Perfect movement in lower extremities.

August 21st: Gradual improvement in all movements except the right hand.

August 29th: Can flex right index finger, but can move none of the other fingers or wrist on right. Can move all the right toes, but cannot

move the ankle-joint. The reflexes on right are greatly increased. The left extremities are normal.

September 2d: Able to move right thumb.

September 10th: Gradually getting more motion in fingers. Has now limited use of all fingers of right hand. Walks all over ward with spastic gait.

September 14th: Except for delayed sensation in left leg and foot, sensation is normal all over body.

September 20th: Goes up and down stairs, but with difficulty. Holds right hand flexed at wrist, and with metacarpo-phalangeal joints extended (Fig. 4).

October 20th: Very little spasticity in gait. Sensation now normal in left leg.

October 29th: Discharged and referred to Orthopædic Dispensary.

July 9, 1917: This date (three years after injury) he paid his first visit to the Orthopædic Dispensary of the Episcopal Hospital, when the following notes were made by Doctor Gill:

Has some atrophy of essential muscles of right hand with a tendency to contracture. Has weakness of triceps of right arm. Active abduction of right shoulder is slightly limited. Has loss of temperature sense on entire left side of body, except left hand and forearm. Has loss of tactile sensation on right side. He is unable to raise toes of right foot from floor. Works as toolmaker.

Proper treatment was advised, but the patient never returned, and cannot now be found; though it is known he was a visitor to a patient in the ward less than a year ago.

END RESULTS OF CERTAIN METHODS OF BRIDGING DEFECTS IN PERIPHERAL NERVES

Doctor Ashhurst presented two patients as clinical evidence of nerve regeneration after methods employed to bridge gaps in the peripheral nerves which are condemned by many neurologists and experimental physiologists. Both nerve stretching and nerve flaps are held to be not only useless, but positively harmful; but he believed these cases prove the contrary. No electrical reports of the muscles supplied by the damaged nerves are presented, because he had come to the conclusion after a not inconsiderable experience in such matters, extending over a period of seventeen years at the Orthopædic Hospital and Infirmary for Nervous Diseases, that where the voluntary contraction of a certain muscle is visible, such evidence is much more reliable than is that obtained by electrical reactions.

Nerve stretching to bridge gaps he had employed timidly and without much elongation of the nerves in his earlier cases; it was not until after repeated attempts at feeble stretching had showed no permanent dam-

age was done to the nerve, that he had been emboldened to employ such forcible stretching as was adopted in Case III (William B.). And the result in this case is so satisfactory, and the method of operation by lateral anastomosis after stretching the ends until they overlap is so much easier than that by nerve-flaps or free transplants, that he should feel no hesitation in preferring it in future cases. It is no doubt probable that in this case the use of free transplants of fascia lata to surround the anastomosis promoted the return of function; but he believes the chief factor was apposition without tension, of broad areas of denuded nervous tissue. The idea of union by lateral anastomosis followed the recognition of the possibility and desirability of determining the extent of scar tissue in the nerve bulbs not by gradually advancing cross-sections as is usually done, but by a longitudinal splitting of the bulb. During suture the bulbs are still in place and by them the nerve may be easily controlled; and after suture he had not excised them, but merely left them as they were. Cases II and III were presented; Case I was absent.

CASE I.—*Primary neuroplasty of the ulnar nerve.* Fred B., twenty-eight years of age, had his left forearm crushed between freight cars, early on the morning of December 12, 1909. He was brought to the Episcopal Hospital, in the service of Doctor Frazier, and was operated upon by Doctor Ashhurst about eight hours after injury. There was a compound comminuted fracture of the radius and ulna, with extensive laceration of the soft parts below the middle of the forearm. The bone ends protruded, and the laceration of the skin extended entirely around the forearm with the exception of about 3 cm. on the extensor surface.

Operation.—Ether. Esmarch band below shoulder. After débridement the ulnar artery was found crushed and its two ends widely separated; both were ligated. The ulnar nerve was crushed, nothing but a grease stained strand of sheath, 3.25 cm. long, joining its ends. After enlarging the incision to within 7.5 cm. of the internal condyle of the humerus and dissecting the ulnar nerve as high as this, as well as down to the wrist-joint, a gap of 1.25 cm. at least remained between its ends, even when put under considerable tension. After repair and fixation of the fractures, a flap 3 cm. long was turned down from the proximal end of the ulnar nerve and was sutured without tension to the distal end by one through-and-through mattress suture, and three sutures passing through the epineurium only. All these sutures were of fine silk. The severed muscles were repaired as well as possible, after swabbing the entire wound with very hot 5 per cent. solution of carbolic acid. The limb was dressed with alcohol-soaked gauze, was placed on splints, and was kept in vertical suspension for twenty-four hours.

The patient's temperature rose to 103° F. on the third day after operation, and there was some suppuration and a great deal of sloughing of skin and muscle; but the wounds were all healed by the end of February, 1910, about two and one-half months after the injury. Good union was

secured in the radius, but the ulna remained ununited. About a year after operation a sequestrum worked itself out from the radius.

The patient was last examined November 17, 1919, ten years after the operation. He continued his work on the railroad, and has no disability from his injured arm. His grip is strong, and he has normal power in forearm, elbow, and wrist. The ulna remains ununited. There is slightly diminished sensation in the ulnar distribution to the fourth and fifth fingers, but normal sensation in the ulnar distribution to the hand. All motions of the thumb and fingers can be performed—there is absolutely no paralysis of any of the thumb muscles, interossei or lumbricals. He cannot make a perfectly tight fist, but this is due to adhesions of the muscles in the forearm to the cicatrix in the skin. It is to be particularly noted that there is no deformity of the fourth and fifth fingers—there is full extension in the phalangeal joints and full flexion in the metacarpal joints, evidencing regeneration of the ulnar nerve.

CASE II.—*End result of primary neuroplasty of the median nerve.* James F., fifty-two years of age, caught his right forearm in a carding machine in the spinning mill where he worked and was at once brought to the Episcopal Hospital. On admission to the Receiving Ward, October 21, 1916, a large gaping wound on the flexor surface was found, and an Esmarch band was at once applied above the elbow to check the free bleeding. The wound was washed with carbolic acid solution (1:40), 1500 units of antitetanic serum were given, and he was sent to the operating room.

Operation was done by Doctor Ashhurst two or three hours after injury. There was a lacerated wound extending from the styloid process of the ulna to the internal condyle of the humerus, and on the flexor surface from the radial to the ulnar border, except for about 5 cm. at the upper end, where the wound tapered to a point at the internal condyle. In the lower part of the wound the radius was exposed, with some superficial destruction of the bone surface. The median nerve was exposed and torn, the radial artery severed, and the muscle bellies and tendons were exposed throughout, but were so lacerated that their identity could not be determined by inspection.

The wound was cleansed with turpentine, followed by soap and hot water, by alcohol, and finally bichloride of mercury solution. The proximal end of the radial artery was identified about 10 cm. below the bifurcation of the brachial and was ligated. The distal end was ligated at the wrist, the intervening portion having been carried away by the injury. The Esmarch band, applied in the Receiving Ward, was then immediately removed. An area of damaged skin, about 2.5 by 10 cm., was cut away. The ends of the median nerve were next identified, and a defect of 5 cm. discovered; even by gentle stretching both ends of the nerve and flexing the wrist it was impossible to make even the damaged ends meet, much less healthy nerve tissue. Therefore, a flap (about 3 cm. in length) was cut from each end of the nerve, the flaps were inverted, and sutured end

to end, without tension, by fine chromic catgut (Fig. 5). The damaged ends of the nerve were not excised, but two ligatures were tied around each to prevent the flaps from splitting all the way to the ends, as indicated in Fig. 5. The lacerated muscles and tendons were repaired as well as possible, and a few silkworm-gut sutures were applied across the wound from one skin edge to the other, but an area about 7.5 by 16 cm. had to be left uncovered. The hand and forearm were wrapped loosely in gauze soaked in alcohol, the limb was placed on a splint, and was suspended vertically for the first twenty-four to thirty-six hours; and for the first week the dressings were kept constantly moist by alcohol douches.

Ward Notes.—October 23, 1916: Patient claims he has perception of touch in hand and fingers, in area of median nerve distribution.

October 28, 1916: Belly of brachio-radialis is beginning to slough. Pain sensation in ulnar distribution. In middle, index and thumb only sensation of touch. Stitches beginning to cut and removed. Temperature 99° to 101°. Wound is 17.5 by 8.5 cm. Still alcohol douches.

October 29, 1916: Tendon of palmaris longus removed for sloughing.

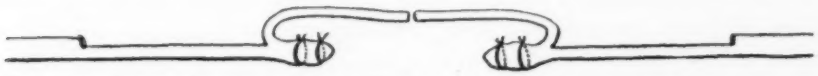

FIG. 5.—Neuroplasty of median nerve, to span a gap of 5 cm. Ligatures applied to prevent nerve ends from splitting beyond the bases of reflected flaps. Case of J. F., 52 years, P. E. H., October 21, 1916.

October 31, 1916: Wound clean except over radial side, where is some exudate. Sensation in thumb, index and middle fingers.

November 1, 1916: Temperature normal and steady.

November 28, 1916: Sixty-two skin grafts applied by Dr. I. M. Boykin.

November 30, 1916: These all disarranged by patient moving, and to-day eighty-two others were applied by Doctor Boykin.

December 10, 1916: All grafts failed to take (infection).

January 6, 1917: Eighteen grafts by Doctor Boykin.

January 8, 1917: Grafts have taken; heliotherapy.

January 31, 1917: Discharged. Slight motion in fingers. Is able to flex and extend elbow somewhat. Wrist extends only to 150° or 160°.

February 5, 1917: Orthopædic Dispensary, Episcopal Hospital. Skin grafts have taken well, wound healed. Wrist flexed to 135°, cannot be extended. Fingers partly flexed. No active motion except slight flexion of fingers. Hand very stiff. To have massage.

May 21, 1917: There is an area of anæsthesia of the thumb, forefinger, and diminished sensation in radial side of middle finger. There is some rotation in the forearm.

October 15, 1917: Can almost touch palm with middle and ring fingers. Forefinger flexes to right angle. No motion in thumb. Sensation present except on inner side and dorsum of thumb.

October 7, 1918: No active motion in thumb except at metacarpal joint.

Can barely touch thumb to little finger; slight passive motion in meta-carpo-phalangeal and inter-phalangeal joints. Unable to make a complete fist. Can barely touch the middle and ring fingers to thenar eminence. Little finger about ⅜ inch from palm, forefinger about one-half normal flexion. None of the fingers can be completely extended. At work since January, 1918, in spinning mill; not the same work as before injury, but almost same wages.

November 20, 1919: Examined by Doctor Ashhurst. He was out of work sixty-four weeks in all. He now makes higher wages than before injury, but in a less important position with the same firm. He uses both hands all day long, in hard manual labor, with grasping actions.

No anæsthesia. All the interossei act, all the lumbricals act. Adduction and abduction of thumb normal. Can appose thumb to index finger *strongly*. Can appose thumb to middle finger with fair power. Can appose thumb to ring finger, mere apposition. Can appose thumb to little finger with difficulty. All the voluntary thumb motion is at the carpo-metacarpal and metacarpo-phalangeal joints; but if the proximal phalanx is held by the examiner's fingers, slight active motion in the distal phalanx (flexor longus) becomes possible. Impairment of function of the flexor longus pollicis seems attributable to muscular rather than to nervous injury, as the lesion of the median nerve, and the site of its suture, was below the level at which its branch to the flexor longus pollicis is given off.

He can flex the index finger at the metacarpal joint to an angle of 120°, and at the proximal interphalangeal joint to 90°.

He can flex the third and fourth fingers until they touch the palm, and the fifth finger until it almost touches the palm.

There is slight atrophy on the radial surface of the thumb metacarpal, but no atrophy of the thenar eminence.

He can extend the wrist fully (no hyperextension) and can flex it to about 135°. Elbow motions are normal. Supination of the forearm is slightly limited.

The large scar on the forearm is supple and painless, the identity of many of the skin grafts being preserved; but the underlying muscles are slightly adherent to the skin in the middle third of the forearm, and these adhesions somewhat limit motions of the fingers.

CASE III.—*Successful end-result of secondary suture of median and ulnar nerves (lateral anastomosis) and many tendons in the forearm.*—Wm. B., eighteen years of age, on August 28, 1916, broke his fish aquarium, and the falling glass cut his left forearm on the flexor surface above the wrist. An immediate attempt at repair was made in the Receiving Ward of the Episcopal Hospital, by the interne then on duty; a number of severed tendons were sutured and the ulnar artery, completely divided, was ligated. The wound suppurated for several weeks, but healed about October 1st. In November, eleven weeks after the injury, the boy was

admitted to Doctor Ashhurst's service in the Episcopal Hospital with a useless hand. There was a cross-shaped scar on the flexor surface of the left wrist, extending to within 3 cm. of the crease of the wrist. The fingers were in full extension and could not be actively flexed, except for very slight power of flexion in the thumb. The fingers were all supple, and could be passively flexed. The wrist motions were normal actively and passively, and the extensor communis digitorum acted normally. There was no action of any of the interossei or lumbricales. There was anæsthesia in the median and ulnar distributions below the cicatrices. There was marked atrophy of the thenar eminence and more marked atrophy of the hypothenar. The thumb, as already mentioned, could be flexed very slightly, but could not be adducted, abducted, nor opposed. The skin above the wrist was adherent to a dense mass of scar tissue, in which all the flexor tendons were caught.

Evidently this was a case of complete block of the median and ulnar nerves, probably from complete division; also of loss of function of all the flexors of all the fingers and thumb, either from complete division or from inclusion in scar tissue.

Operation was undertaken November 15, 1916, nearly three months after the original injury. Under ether anæsthesia, and with Esmarch anæmia secured by applying the rubber band just below the shoulder, the longitudinal portion of the old scar was excised, and the skin on both sides was reflected. It was densely adherent to the tendinous cicatrix in the middle of the incision, but free proximally and distally.

A. By dissection the following structures were identified: (1) Palmaris longus, its proximal end being lost in the scar; no distal end was found. (2) Flexor carpi radialis; by extending the incision through the annular ligament, the flexor carpi radialis was traced and found to be carefully sutured to the distal end of the median nerve (bulbous). (3) Proximal end of median nerve, ending in the mass of scar tissue, with a bulbous extremity 1.25 cm. in length. (4) Ulnar vessels and nerve, both distal and proximal ends terminating in the mass of scar tissue, and their ends separated by 2 to 2.50 cm. The ulnar nerve evidently was completely divided by the injury and not sutured. (5) Cicatricial mass of superficial flexors, the distal ends of thumb, index and middle tendons not being united to the proximal ends. (6) Cicatricial mass of deep flexors, nowhere completely divided but adherent to the underlying bones and to the scar mass of the superficial tendons. All adhesions were dissected free.

B. The proximal end of the ulnar artery was newly ligated, as the dissection had opened its lumen. The following suturing was done: (1) The flexor carpi radialis was detached from its accurate end-to-end union with the median nerve, and was sutured to the flexor pollicis longus. (2) One of the unattached proximal ends of the superficial flexors was sutured to the flexor of the index finger. (3) The palmaris longus was sutured to the flexor of the middle finger. (4) The median nerve ends could not

be made to meet even after the dissection, and with the wrist flexed; therefore its proximal end was stretched for 5 cm. by pulling on the bulbous end with hæmostatic forceps. In this way the bulb was pulled down past the distal end. Both ends of the nerve were then denuded laterally on apposing surfaces and united by lateral anastomosis by means of three fine silk mattress sutures passing completely through the nerve (Fig. 1). (5) The ulnar nerve was treated similarly, after stretching its proximal end for about 4 cm. In this way broad surfaces of healthy nerve tissue were brought into apposition without tension. The Esmarch band, in place about one hour, was now removed. It was found no ligatures were required.

C. A portion of fascia lata, about 8 by 10 cm., was next excised from the region of the left great trochanter. This piece was cut in half (4 by 10 cm.), and one of these smaller pieces was again halved, giving two

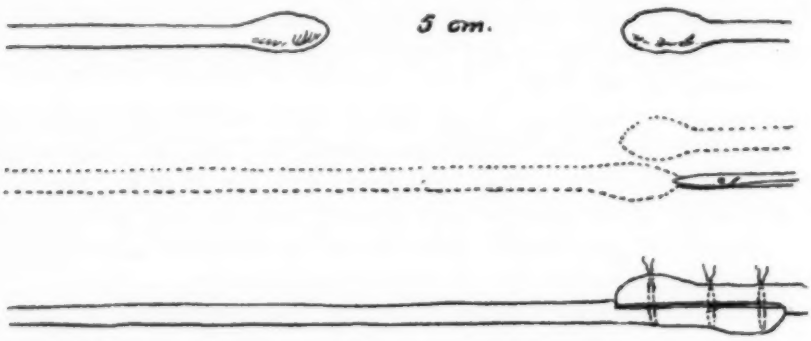

FIG. 6.—The bulbous end of nerve is caught in forceps and the nerve is stretched until the two ends overlap. They are then denuded on apposing surfaces, and united by lateral anastomosis. An actual gap of 5 cm. in the median and 3.25 cm. in the ulnar nerve was thus bridged. Case of W. B., aged eighteen years, P. E. H., November 15, 1916.

pieces about 2 by 10 cm. in dimensions. One of these small pieces of fascia lata was sutured around the median and the other around the ulnar nerve anastomosis, as tubes, being fixed proximally and distally to the nerve sheath by interrupted sutures; the suture for closing the tube in its long axis being continuous. The suture material was No. 000 chromicized catgut, threaded in a fine round needle. The remaining portion of fascia lata, 4 by 10 cm. in dimensions, was arranged so as to form one tube surrounding the bundle of the superficial flexor tendons, including those just sutured; this was to prevent adhesions between the superficial and deep flexors in the depth of the wound, and between the superficial flexors and the skin superficially. This portion of fascia lata was sutured around the tendons and fixed by sutures to the fascia surrounding the tendons as in the case of the nerves. The superficial fascia and the skin were finally closed in separate layers with many interrupted sutures of No. 0 chromic catgut, and the forearm was dressed on a splint.

The duration of the operation was two hours.

Healing occurred uneventfully. The splint was removed at the end

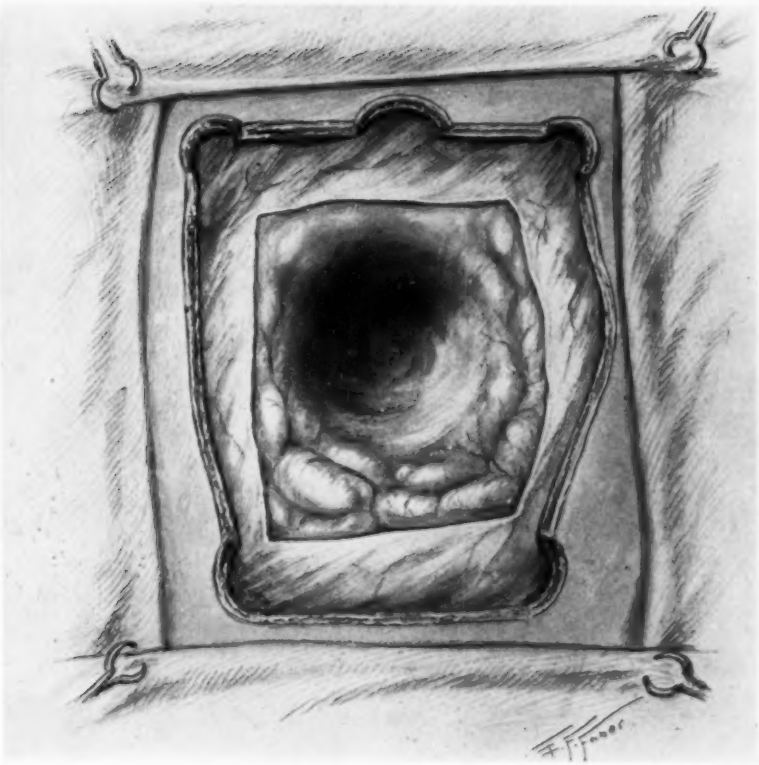

FIG. 3.—J. T., aged thirty-one years, P. E. H., January 6, 1920. Jacksonian epilepsy caused by brain tumor. Depression in brain from which tumor was removed, showing flattened convolutions. Re-drawn from a sketch made at the time by Dr. Mendel.

FIG. 4.—Case of hæmatomyelia three months after injury of cervical cord, showing residual paralysis. Episcopal Hospital.

FIGS. 7 AND 8.—Three years after secondary suture of median and ulnar nerves, above wrist. Gap of 5 cm. in median and of 3.25 cm. in ulnar; spanned by forcible stretching of proximal ends of nerves, until bulbous ends overlapped. Lateral suture after denudation of opposing surfaces of nerves.

of the second week, and treatment by massage was instituted. This was continued for a year after operation, when approximately normal function had been regained. The patient was able to return to his work in a mill three weeks after the operation.

Examination in November, 1919, three years after operation, shows very little trace of the accident. There is slight fixation of the skin to the underlying tendons at one point. Full regeneration has occurred in both median and ulnar nerves, as evidenced by normal action of all the lumbrical muscles, of the abductor, adductor, short flexor and opponens muscles of the thumb, and by very nearly normal action of all the interossei; the only deficiency in the interossei is slight weakness in spreading the fingers apart (Fig. 7). Each finger can be moved separately in flexion and in full extension, though flexion is possible only until the finger tips touch the base of the palm; they cannot be flexed actively into actual contact with the middle of the palm, but there is normal power in the grip, and no disability in hard manual labor (Fig. 8). The thenar and hypothenar eminences are less well developed than in the normal hand; indeed, the entire left hand is somewhat smaller than the right. The deep and superficial flexors of all the fingers act separately, showing that they are no longer adherent to each other above the wrist. The thumb can be apposed to each finger, but not with much power to the fourth and fifth. There is, however, no power in the long flexor of the thumb, the distal phalanx remaining extended when the flexor brevis acts. As the distal end of this tendon was sutured to the proximal end of the flexor carpi radialis, the fact that it does not act cannot be attributed to failure of regeneration in the median nerve, the nerve lesion having been well below the level where its branches to the flexor longus pollicis and flexor carpi radialis are given off.

The movements of the wrist, active and passive, are normal. The lad works as an electrician, and is conscious of no disability in the use of his hand.

Dr Charles A. Elsberg, of New York, regarding the two cases (II and III) showing results of bridging defects in peripheral nerves, said that no matter how good the result one might get in rare instances, all evidence points to the fact that turning down a flap from a nerve from above or turning up a flap from below in order to bridge a defect is inadvisable. If regeneration occurs it has to take place in spite of the procedure and not as a result of it.

The literature of this subject was carefully gone over six months ago by Doctor Stookey, of New York, who published his conclusions in the *Archives of Neurology and Psychiatry* three or four months ago. He showed pretty conclusively that not a single instance, and certainly not in the original case of Letievant, could any regeneration be attributed to the procedure. Throughout the entire literature not a single permanent result was to be found. In one or two cases there was improvement, but

Stookey concluded that the improvement occurred in spite of the procedure and not as the result of it.

Regarding Doctor Ashhurst's third case, he could not agree with him that in sectioning the bulbous ends of divided nerves, it is difficult to determine when normal funiculi are reached. There is an essential difference between the central and peripheral end bulbs. In making successive cross-sections of the central end, one first sees one or two funiculi and the number gradually increases until the whole mass of normal funiculi is seen. In the peripheral end, however, one usually sees nothing but white scar tissue in each successive section until one section suddenly exposes a number of normal looking funiculi. In his experience, the question is largely one of understanding the funicular structure of the peripheral nerves and the appearance of normal funiculi.

The much spoken of case of MacKenzie did not prove anything. In his operation a large flap was turned up from the external popliteal and its branches in order to bridge a large defect of the sciatic. Careful study of MacKenzie's reports do not convince one that there was any real regeneration in his case.

SPECIMEN OF BRAIN TUMOR OF UNUSUAL DIMENSIONS REMOVED FROM A CHILD OF SIX YEARS

Dr. Charles H. Frazier, M.D., presented a specimen to the Academy because of its unusual size, because of its peculiar surface markings, and because of the comparatively short duration of any symptomatic evidence of an intracranial growth. The patient, a child six years of age, was perfectly well until within five months of the operation. At that time the following symptoms were observed in the order mentioned: Vomiting, dulness, apathy, hemiplegia and imperfect vision. Upon examination the following clinical features were observed: (1) Head enlarged, suggesting hydrocephalus with distended superficial veins of scalp; (2) papillœdema of 4 D in each eye; (3) spastic hemiplegia, left; (4) convolutional markings of frontal bone.

Operative Record.—The operation was performed at three sittings. At the first the tumor was uncovered, but the enfeebled condition of the child did not seem to warrant further intervention at that time. One week later the flap was reflected and the tumor removed. It was easily differentiated from the surrounding brain tissue and seemed in size to occupy a space at least half as large as one hemisphere. The surface markings were not unlike that of the brain cortex, and those witnessing the operation thought a portion of the hemisphere was being removed. There was comparatively little bleeding until the tumor was finally separated from the falx. Hemorrhage was then profuse and could not be controlled except by pressure with a large cotton tampon. Any attempt to remove this tampon was always attended with recurrent bleeding.

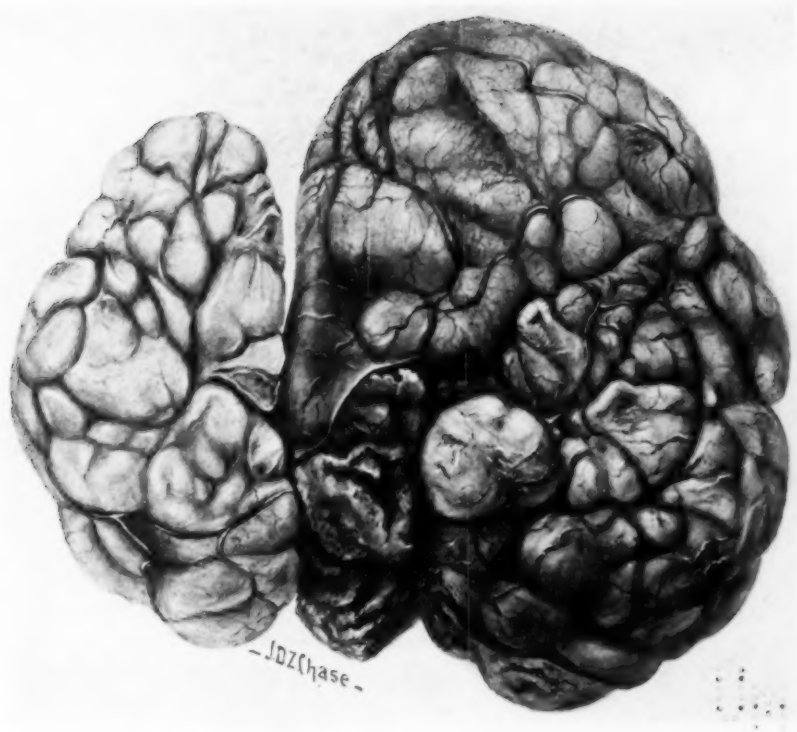

FIG. 1.—An endothelioma of the brain, composed of two sections apparently distinct, the one to the left measuring 7.5 x 4 x 3 cm. and that to the right 10 x 10.5 x 4.5 cm. The surface markings resembled somewhat the cortical convolutions and its capsule a pial membrane.

Accordingly the cotton tampon was allowed to remain *in situ* and the wound closed without drainage.

The presence of the large tampon gave rise to no disturbing symptoms until the fourth day, when there was a slight rise in temperature and a convulsive movement of the arm. The patient was taken to the operating room, where under very light ether anæsthesia the flap was again reflected, the dura opened, and the cotton tampon removed. Fortunately there was no recurrence of hemorrhage. The cavity was filled with salt solution and the wound closed for the third time.

Pathological Report.—Endothelioma. Specimen composed of two masses: (1) 10 by 10.5 by 4.5 cm.; (2) 7.5 by 4 by 3 cm. Irregular and nodular, covered with pial-like membrane. Surface convolutional. Interior composed of lobules yellowish gray in color (Fig. 1).

Summary.—Attention is called to the size of the growth; to the fact that despite its size the child was symptom-free until five months before its removal; to the peculiar convolutional markings; to the tolerance of the patient to the three operative sittings, and particularly to the tolerance of the patient to the large tampon of cotton, which replaced the tumor.

CANCER OF BOTH BREASTS

DR. J. S. RODMAN reported a case of sarcoma of the left breast and carcinoma of the right breast in same patient. Double amputation. Subsequent development of mediastinal metastasis. His reasons for reporting the case were: (*a*) Association of sarcoma and carcinoma in same patient. (*b*) Unusual length of life considering advanced state of disease. (*c*) Apparent arrest of mediastinal growth by X-ray.

The patient, a woman forty-six years of age, had known of tumor in left breast for two years. No pain, no trauma, no discharge from nipple, no abscess, but remembers that during first lactation left breast was "sore." Could not nurse second child because she did not have sufficient quantity of milk. Tumor remained about size of English walnut until six months prior to operation. Grew rapidly in this period, during which family physician was treating it with X-rays at first twice weekly and for the last five weeks daily. Was pronounced inoperable by another surgeon six months prior to operation.

Physical Examination.—Large solid tumor mass size of infant's head filling entire left breast. No retraction of nipple. No discharge from nipple. Not tender. Movable on chest wall. Axillary glands palpable.

Operation (October 28, 1910).—Dr. W. L. Rodman. Radical breast amputation, left breast, "Rodman" technic. There was a pathological controversy over the tumor. Two pathologists thought that it was not malignant, but fibro-cyst-adenoma, while the third thought it was unquestionably sarcoma.

In April, 1911, five months after amputation of left breast, she first noticed a small swelling about the size of an English walnut in the

lower inner quadrant of the right breast. There has been no increase in size of this tumor mass since first noticed. Breast is painful at times, especially at menses. As was the case with the left breast, there has been no history of trauma, no abscess, or discharge from the nipple. She has noticed a slight retraction of the nipple for the past three months.

Physical examination of right breast shows slight retraction of nipple. There are tender masses throughout the breast tissue, the largest of which is centrally located. Breast freely movable, no discharge from the nipple.

Operation (November 11, 1911).—Amputation of right breast, W. L. Rodman. "Rodman" technic.

Pathological Diagnosis.—Carcinoma of breast. Routine post-operative X-ray treatment following each breast amputation.

About eighteen months after amputation of the left breast and five months after right breast was removed, a bulging of the sternum was first noticed. X-ray showed this to be due to a mediastinal tumor for which she has been under X-ray treatment and observation since. Dr. S. E. Pfaller, who has given the X-ray treatments, states that the mediastinal growth is now calcified. She has gone for one year at a time without X-ray treatment, but is still considered as being under treatment.

Condition at present time, ten years after amputation of the left breast for sarcoma, nine years after amputation of the right breast for carcinoma, and eight and a half years after the mediastinal tumor was first noticed, is reasonably good. Her weight is about normal. The scars of operation show no sign of local recurrence. There is still marked bulging of the sternum, but probably no more marked than when first noticed. For the past six weeks she has had "choking spells" which come on suddenly during which she eructates quantities of gas and from which she gets almost immediate relief after sitting down. Her general physical examination reveals nothing to account for these seizures.

WELCH BACILLUS GANGRENE

Dr. John H. Jopson read a paper with the above title.

Dr. DeForest Willard related a case seen by him in Hospital No. 1 in Paris in which the sera treatment was used in gas gangrene. It was that of a soldier with gunshot wound of the leg in which amputation had already been done in the middle third for gas gangrene. He came in in a distinctly shocked condition, with pulse very high and temperature moderately high. He was perfectly clear mentally. The thigh above the point of amputation was much swollen and very œdematous. The man was in extremis. Previously Professor Vincent, of the French army, whose polyvalent serum was being used exclusively, had given to the hospital staff a talk on his treatment. Professor Vincent was asked to come up and see this case. He gave the man, according to Doctor Willard's recollection, 60 c.c. intravenously. This was at four or five o'clock in the

afternoon. The man was then thought to be in extremis. The next morning his pulse was good, below 100; temperature was down, swelling and œdema in his leg had decreased, and he from that time went on to recovery.

ABSCESS OF THE LUNG

Dr. John A. Hartwell read a paper with the above title, for which see page 333.

Doctor Müller said that he had often wondered why abscess has not been more frequently observed after lobar pneumonia. That it is common in cases of pneumonia coming to autopsy was well shown by Lord in 1915. He found abscesses in about one-fifth of the cases of bronchopneumonia and about one-fourth of the cases of lobar pneumonia. He suggests that the clinical infrequency of abscess in lobar pneumonia is more apparent than real and that certain cases of pneumonia are complicated by small losses of pulmonary substance which proceed to full recovery. Doctor Hartwell has shown us how this may occur and quite clearly the etiology of empyema from rupture of the peripheral abscess, a point recently manifested by Doctor Moschcowitz in his several papers. It is necessary to depend to some extent on classification in order to clearly determine in our minds the matter of treatment. Gangrene may be massive from obstruction of its blood supply or minute from the necrotizing action of an acute infection at the point of the abscess. Obstruction by foreign body may result in an abscess with bronchiectasis. Drainage, partial or complete resection, will depend upon the particular type which we encounter.

Dr. Howard Lilienthal said that Doctor Hartwell had shown a magnificent series of lung abscess operated upon by drainage with wonderful success. Other cases he has especially mentioned would probably not be cured by drainage, but only by radical procedures, such as lobectomy. It is my belief that all the abscesses which come from blocking of the bronchi and which are sponge-like are impossible to drain. No patient with a thoroughly established abscess of this kind, which has lasted for more than two months, will be cured by attempted drainage. That patient must be satisfied by such relief as may be afforded by washing out with a bronchoscope, but he has still a progressive disease. To be really cured he must submit to a resection of the lung, which is a dangerous operation. However, when that lung has been resected and the patient has recovered from the operation, he is well. The gangrenous abscesses, as Doctor Hartwell calls them, I have been afraid to operate upon by resection. I have treated them by incision and drainage, with varying results. The chance of curing a case of this kind by drainage is not bad if he withstands the immediate consequences of the operation, but the danger is very, very great in these acute gangrenous abscesses. It had been his custom to watch from day to day with a fluoroscope or

with X-ray pictures, and if he saw that they were increasing in size, the patient running septic temperature, he operated, but with a high mortality rate. He did not believe in the indiscriminate aspiration for the purpose of locating an abscess which one wants to operate upon. The X-ray and bronchoscope will locate the abscess without the danger of infecting the chest wall with anaërobes from aspiration puncture. I have recently seen two patients die without operation merely from chest-wall phlegmon following aspiration.

Doctor Hartwell seems to have had very wonderful success by the drainage of these abscesses. In the last six years the speaker had drained twenty-three of these abscesses and had saved 34 per cent. and a fraction. Another 34 per cent. have died and 30 per cent. are alive but not well, not speaking of the bronchiectatic abscesses. Of those he had had eighteen. He had refused none for operation. He had resected the lobe and lost 55 per cent.; the others are well—no cough, no signs of disease. From the therapeutic end of the subject it is important to remember that in the bronchiectatic abscess it is probably wiser even with the big risk to perform resection or removal of a lobe than merely to attempt to drain. I used to drain these cases and lost nearly every one from hemorrhage sooner or later after operation. If an abscess is a very large one and the danger of pneumectomy is too great, an operation has been attempted of ligating the pulmonary artery. There are other procedures which cannot be gone into now. The case which Doctor Hartwell showed in which the lung had apparently disappeared and in which there was a pneumothorax which was not perfectly aseptic but which really closed from the outside, was very illuminating. In a patient of that sort in which he had removed the two lower lobes and part of the upper lobe, and in which the rest of the upper lobe atrophied, the man was perfectly well, but twice has had a reopening with a little discharge from the chest. This closed and the man is now well and at work.

THE MANAGEMENT OF TOXIC GOITRE FROM THE SURGICAL POINT OF VIEW

Dr. Charles H. Frazier read a paper with the above title, for which see page 155, August, 1920.

Dr. Charles N. Dowd remarked that in hearing Doctor Frazier's paper one must be impressed with his method of estimating the patient's strength and then fitting the surgical procedure to it. This is the essence of goitre surgery. The individual surgeon must fit his procedure to the individual patient.

The estimation of the patient's strength depends on clinical observation rather than upon reading. When men write about the grades of toxicity we do not know that their standards are the same. One man's "moderate toxicity" may be another man's "severe toxicity."

Doctor Frazier, in an earlier paper, noted the sparsity of reports from

the Atlantic seaboard as compared with the interior of the country. It is possible that different localities differ in type of goitre as well as in its general prevalence, and this difference must be interpreted in planning treatment for the individual patients.

Many observers have adopted a classification which corresponds fairly well with the three main groups of Plummer and Wilson: (1) Non-hyperplastic non-toxic. (2) Non-hyperplastic-toxic. (3) Hyperplastic-toxic.

The groupings on this basis as made by five observers are indicated in the following table:

	I	II	III
Frazier	35.7 per cent.	31.6 per cent.	32.6 per cent.
Wilson and Plummer	43 per cent.	14 per cent.	42 per cent.
Rogers			25 per cent.
The writer (137 hospital cases reported in 1915)	48.1 per cent.	27.5 per cent.	24.4 per cent.
The writer (61 later personal cases)	20 per cent.	55 per cent.	24 per cent.

We thus see that there is considerable variation either in the type of cases or in the interpretation of their toxicity.

Among his later cases the writer has seen many who are either entirely unsuitable for operation or only suitable. For example: (1) A man of forty who had recently come from Ohio with typical symptoms of acute hyperthyroidism, died at his home during the short period which was given to the making of the desirable laboratory tests. (2) A woman of sixty, who had suffered for many years and who had reached the terminal stage of degeneration of the internal organs, was almost moribund when seen and died a few hours later. (3) There were four cases who reacted fairly well to the preliminary ligation of the superior thyroid arteries but who refused, or procrastinated, the secondary operations when the suitable time had arrived, and thus became extremely toxic. (4) There were other cases in whom the diagnosis was not clear. It was doubtful whether the symptoms were really dependent upon the goitre.

It is manifest that the method of dealing with cases must be selected with care and that suitable recourse should be made to X-ray, boiling water injection, rest, medication, anoci procedure, or whatever seems indicated.

Most surgeons must learn some of this by experience. Personally, the writer had developed considerable confidence in the possibility of dealing successfully with the difficult cases by operation, but the procedure was interrupted by three fatalities within two years; one, an extreme case of hyperthyroidism who died under a preliminary ligation, and the other two moderately severe cases who died, one of œdema of the lungs and the other of pneumonia, each two days after operation. These fatalities naturally made a radical revision of standard of operation, and since then it has not been difficult to operate on a continuous series of

seventy-six cases without mortality; a series which is not larger when compared with the reports of several other surgeons and which without question embraces a lower average of severe toxicity than does the previous group.

Dr. John Rogers said that he agreed with Doctor Frazier concerning the value of the mechanical tests; that is, they are far from being definite and infallible and to be of any value must be compared with the clinical findings. The calorimeter test which shows the rate of metabolism is the most useful. I was somewhat disappointed in Doctor Frazier's indications for operation. For it is possible to divide these cases into more or less easily recognizable groups according to the extent and location of the diseased alveoli in the thyroid; and each of these groups can be best treated by its appropriate type of interference. It is now generally accepted that the symptoms of the so-called "toxic" goitres are produced by some abnormal secretion which emanates from certain hyperplastic alveoli. If the diseased tissue is removed the toxic symptoms disappear.

1. When these symptoms occur in the presence of a goitre which is symmetrically enlarged and of even consistency throughout it is presumable that all the hyperplastic tissue cannot be excised unless the entire gland is sacrificed. If one-half or two-thirds of the organ remain this small portion may contain enough hyperplasia to continue the disturbance. In these cases I advise the ligation in two stages of all four of the chief thyroid arteries. My results in several hundreds of such cases show ultimate cures by this operation in the neighborhood of 90 per cent.

2. When one lobe is much larger and denser than the other it is presumable that all or the greater part of the hyperplasia can be removed by excision of the most diseased lobe. In addition, and at the same time, when there is doubt about the remaining lobe, its superior thyroid vessels can be ligated. This limited use of hemithyroidectomy is most satisfactory when one becomes accustomed to examining the gland with a view to the histology of its contents.

3. When the toxic symptoms emanate from the interior or immediate circumference of a toxic adenoma or cystadenoma, the symptoms will disappear almost immediately after enucleation or excision of the adenoma. All the sound tissue possible should be preserved. It is generally immaterial whether at the same time both or one of the superior thyroid vessels are tied. I generally practice this procedure as a precaution against relapse. I wish to protest most emphatically against the present widely accepted advice, to excise in all so-called "toxic" goitres, four-fifths or five-sixths of the gland. In the first place, the symptoms of "toxicity" are by no means well defined nor clearly understood even by the most experienced. In the next, the thyroid gland is far from being a functionally useless or unimportant part of the organism, and experience has abundantly demonstrated that a "toxic" goitre may under indifferent or non-surgical treatment change into a simple or non-

toxic and otherwise symptomless goitre. That is, the hyperplastic alveoli may and can change into the normal type. It is generally understood that these cases will show hypothyroid symptoms at one period and at another, perhaps six months later, show distinct signs of hyperthyroidism. I have observed this so often and in such regular sequence that I have before this called attention to what seems to be the natural history of the disease. It apparently begins with the symptoms and history which are those of fatigue, and it can only be distinguished from simple fatigue by the presence of a perceptible thyroid enlargement. This initial stage may then pass into a true myxœdema or more or less gradually be followed by the signs of so-called hyperthyroidism, to which exophthalmos may or may not be added. If these observations are correct they mean that the patient with hyperthyroidism is suffering not necessarily from too much thyroid but from an abnormal functionation of the thyroid. Such an individual seems to be endowed with, or to have acquired, a thyroid which in attempting to perform its duties "gives out" or "runs amuck." The impulses which thus seem to drive the organ beyond its capacity must in part, at least, reach it through the circulation, and hence it is logical to cut off these impulses and to enforce "rest" upon the gland by ligating its chief afferent vessels. To ruthlessly sacrifice three-fourths or five-sixths of this gland, as is so frequently advised, especially in a patient who gives a history of a longer or shorter period of hypothyroidism preceding that of the hyper stage, is, I am convinced, to inflict in many instances an irreparable calamity. With the prevailing uncertainty in the interpretation of symptoms and the inexperience of the many operators who enter this field, it is far wiser to preach conservation rather than destruction of this important organ. Doctor Frazier failed to discuss, at least at any length, the clinical evidences of "toxicity." In my laboratory studies upon the effects in dogs of the injection of various thyroid extracts and derivatives, the reactions have almost from the outset been recognized as confined to stimulation of the functions believed to be performed by the terminals of the autonomic or vagus system of nerves. The terminals of the opposing or sympathetic system seem never to be affected.

The autonomic system seems to have the general effect, as determined by electrical and chemical experiments, of stimulating vascular and functional activity. The sympathetic terminals, on the other hand, apparently have the opposite effect, or that of inhibition of vascular and functional activity. Adrenalin and all derivatives of the adrenal gland which contain adrenalin are accepted as having a selective and stimulant affinity for this particular group. In general, therefore, the autonomic nerve terminals with their affinity for the thyroid product, may be said to "drive" the viscera, while the sympathetic adrenal combination shows an opposing or "check" influence. Hence, in the presence of an overacting thyroid gland there is evidence in the skin, circulation, and viscera of

too much " drive." If the thyroid is underactive there is an apparent insufficiency of " drive "—tachycardia is directly traceable to the influence, not of the vagus, but of the sympathetic nerve, and in my laboratory tests I have never found any normal or pathological thyroid derivatives which would, within the usual period of a few hours necessary for kymograph tracings, excite any appreciable degree of tachycardia. If, however, the thyroid feeding is continued for many days the result corresponds to the accepted dogma. Then there does follow tachycardia and increased metabolism. This does not prove that the thyroid activates the sympathetic. It seems more probable that the tachycardia is due to acceleration of the entire bodily chemistry, and perhaps directly to increased metabolism of the heart muscle itself. Hence, one should at least be cautious in believing that every case of tachycardia with a " goitre " requires the destruction of the greater part of the supposedly offending thyroid gland.

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